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JUNE, 1941

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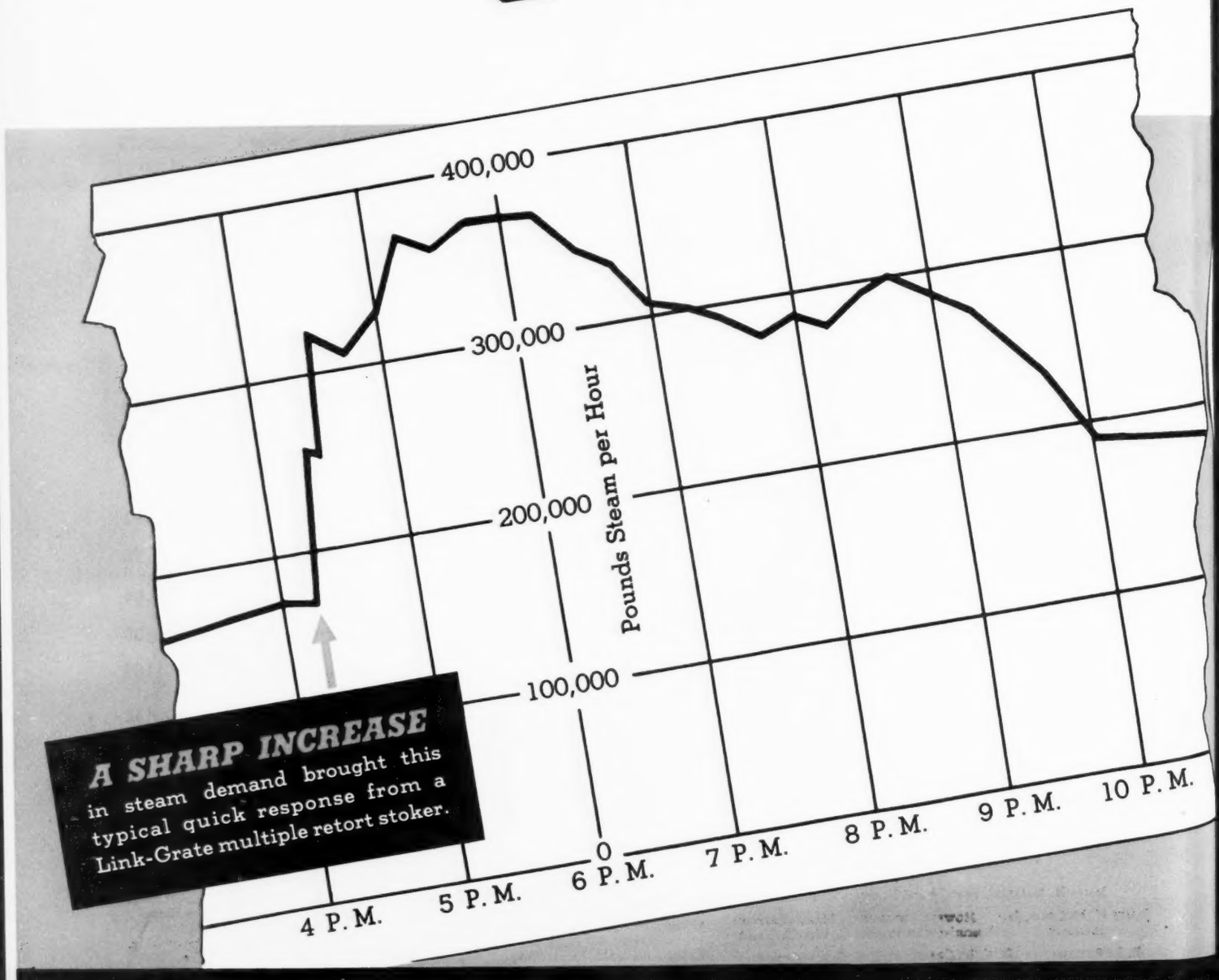
quick pick-up



A SHARP INCREASE in steam demand brought this typical quick response from a Link-Grate multiple retort stoker.

Westinghouse

POWER

Established 1882 • PHILIP W SWAIN, Editor

Pioneering in Wind Power

Elsewhere in this issue (page 56) is an account of a remarkable pioneering venture—the Smith-Putnam 1000-kw wind turbine plant now nearing completion on Grandpa's Knob, near Rutland, Vermont. In an age when the wind has been relegated to minor farm chores while all major power demands are served by steam, hydro and internal-combustion engines, this plant will attract wide attention.

Recent years have seen various attempts to revive the "windmill" as a modern well-engineered wind turbine, but nothing on this scale or of this quality. The plant sets many new records: largest aero-electric power-generating unit—first to supply alternating-current for commercial use—first ever paralleled with a public-utility system.

Such records fire the imagination, but Associate Editor Fred Annett, who flew to Burlington to visit this plant, finds deeper significance in the 180-ft anemometer tower for studying wind vagaries and in the multiplicity of testing and control circuits leading from the wind turbine to the underground laboratory. Above all else, as he points out in his article, this is a research project. It will lay a solid scientific foundation for wind-power progress.

From top to bottom the unit is equipped with testing devices to answer technical questions—to show how the adjustable wings control speed in gusty weather, how they perform in sleet and ice, what is the efficiency under various conditions, what are the operating stresses, which parts are stronger than necessary. Such facts could not be determined in a laboratory-size unit; this experimentation had to be done at great cost on a commercial scale, or not at all.

Granting the value of such information, the practical POWER reader will ask whether there is any reasonable chance that wind power will be a "paying proposition" in our time. A fair answer must recognize that power systems depending on wind *alone* are definitely out of the picture—also that storage batteries as standby are prohibitively expensive except for small and remote installations.

There remains the possibility that well-engineered wind turbines may be economical in certain regions of favorable winds, if they can be tied in with power systems of proper characteristics, preferably systems including both steam and storage-type hydro plants. Under such circumstances wind power can save fuel and at the same time add to the peak capacity of the system by conserving off-peak water.

Some day America must face an acute problem of post-war adjustment—the need to find new activities to replace a slackened national-defense effort. Over the next few years technical research in hundreds of directions must build a stockpile of answers through such courageous pioneering as this Smith-Putnam wind-power project.

World's Largest Wind-Turbine Plant Nears Completion

On a mountain top in Vermont, S Morgan Smith Co is constructing a 1000-kw aero-electric plant and wind-power research laboratory to find out whether large-scale power generation from the wind is economically possible

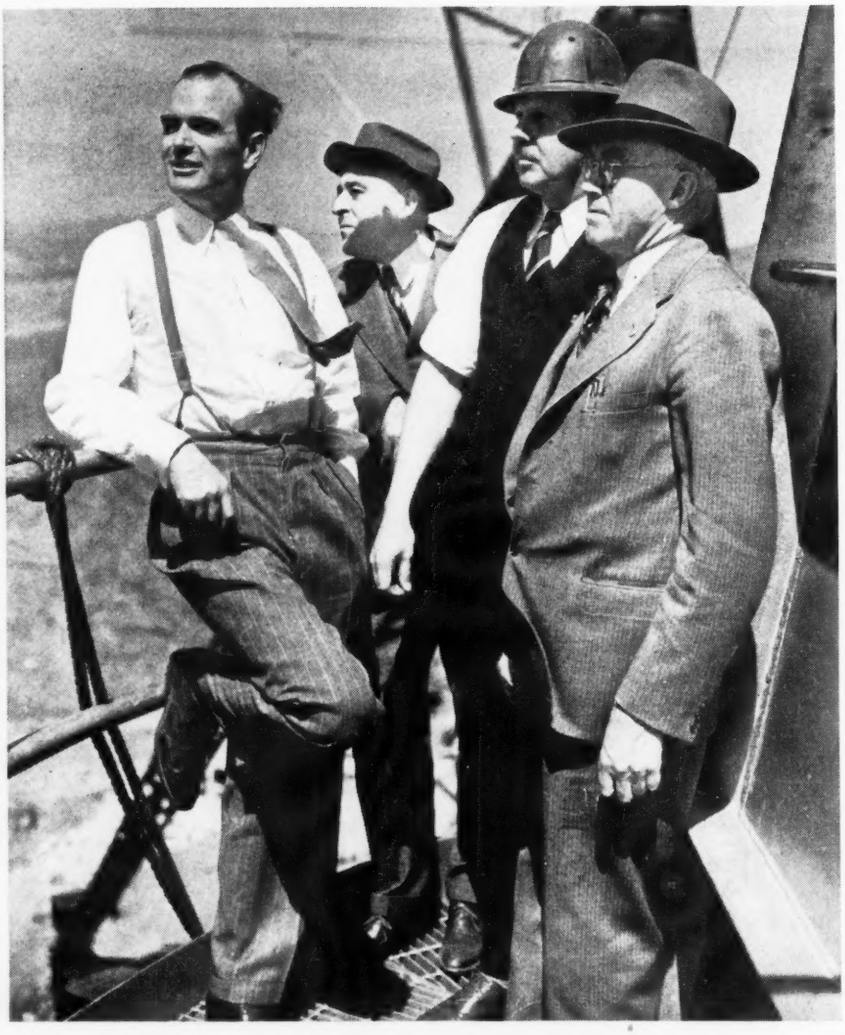


Fig. 1—(Left to right) Palmer Cosslett Putnam, inventor of the wind turbine; W Belding, superintendent of power, Central Vermont Public Service Corp; Stanton D Dornbirer, erection engineer, S Morgan Smith Co; and F A Annett, Associate Editor, POWER, on top of the wind-power-plant tower looking toward the heavy timber strut that will temporarily support the free end of the pintle girder during assembly of the power equipment and the supporting structure of the wind turbine

▶ WINDMILLS HAVE SERVED MAN for many centuries as small power units to grind his grain, pump his water and, in more recent times, to generate his electric power. Outside of a change from wood to steel construction they have remained practically the same old windmills of song and story. Recent developments in aerodynamics, metallurgy, aerology and related technology have made possible the production of the Smith-Putnam wind turbine, invented by Palmer Cosslett Putnam, a Boston engineer, which gives promise of economic large-scale power generation from the wind.

This work has progressed so far that in a few weeks the largest aero-electric-power-generating unit ever built and the first to supply alternating current for commercial use, will go into service. The installation is being made on top of a 2000-ft mountain, Grandpa's Knob, near Rutland, Vt., and will tie into the power system of the Central Vermont Public Service Corp.

Built at a cost of several hundred thousand dollars, this installation combines one of the largest industrial research projects ever attempted with a 1000-kw wind-power plant. The research work is divided into (1) an exhaustive study of winds, and (2) of wind-power-plant performance to provide the fundamental and engineering knowledge necessary for economic design, construction and operation of such plants. After the research work is completed there will remain an aeroelectric plant to produce power for the local utility system.

The pintle girder, on which the entire plant is supported, was hoisted into place on April 26, and the project is expected to be ready for operation sometime this month. Associate Editor F A Annett, POWER, who was on the scene just before the girder was lifted, had photographs taken of the hoisting operation by Donald C Guy, Rutland (Vt.) Daily Herald. These appear on page 90 of this issue.

The entire wind-power plant is balanced on top of a structural steel tower 110 ft high, 36 ft sq at the base (see Fig. 2) and anchored into the mountain top with a steel grillage and concrete foundation 23 ft deep. This tower was built by the American Bridge Co and near it a 180-ft anemometer tower has been erected for measuring and recording wind velocities during the experimental period.

Anemometer Installation

On the anemometer tower are 19 instruments of three different designs, placed on long spars at several levels. Some of the anemometers are gas heated so that wind velocities may be studied during the severest ice storms. Each anemometer connects to an automatic recorder in a wind-research laboratory at the foot of the tower. This laboratory is also equipped with automatic wind-direction recorders and equipment for control of the heating of the anemometers.

A heavy plate-steel-girder structure, called the pintle girder, forms the foundation for the plant. It inclines downward toward the wind at an angle of 12.5 deg so that the turbine shaft makes a similar angle to the horizontal (see Fig. 2). The pintle girder, the heaviest single part of the plant, is supported at *A* on the top end of a pintle shaft. This shaft has a double roller guide bearing just below the girder at *B* and a combination roller guide and thrust bearing at *C*, which leaves the whole plant free to yaw (swing) with the wind.

The blades and their control mechanism overhang one side of the tower and approximately balance the rest of the equipment on the other side. The blades, constructed of shot-welded stainless steel by the E G Budd Mfg Co, are over 11 ft wide by 65 ft long and weigh 15,300 lb each. Supporting the blades from the end of the shaft presented many difficult design problems. The supporting structure not only has to cantilever the weight of the blades into the shaft, but weight of the blades may double during an ice storm. Furthermore, the ice may heavily unbalance the two blades. Heavy centrifugal forces must also be taken into account, in addition to various aerodynamic forces produced by winds up to 140 miles per hr.

As shown in Fig. 3, a heavy structural steel hub-post about 16 ft long projects at right angles to the main shaft and is securely attached to it by a central hub. Each blade is supported by its shank from the hub-post by a heavy structural-steel A-frame hinge at *H*. Structural-steel coning struts tie the outer ends of the A-frames to one end of crank arms pivoted in the downward end of the hub, which extends out about 10 ft from the hub-post. The other end of the crank arms connect to hydraulic-cylinder pistons that act as oil dashpots to stabilize the coning of the blades under the impact from gusts of wind.

Two heavy roller bearings support each blade shank—one a combination radial and thrust design in the outer end of its A-frame support and the other a radial type in the hub. At their inboard ends, the blade shanks connect by short cranks and linkages to a hydraulic piston in the shaft in such a way that the pitch angle of the blades can be changed through an angle of nearly 100 deg. Pitch of the blades is controlled in very much the same way as blade pitch is regulated in a Smith-Kaplan hydraulic turbine.

Turbine-Blade Motions

The blades therefore have three motions: First, they are driven by the wind to rotate the main shaft at 28.7 rpm. Since the blades span 175 ft, a speed of 28.7 rpm gives them a tip speed of 15,785 ft per min compared to around 6000 ft per min for a propeller type hydraulic turbine.

When the blades are being driven at normal speed, centrifugal force holds them at nearly right angles to the main shaft. If a sudden gust of wind hits them they can cone down-wind to a maximum of 20 deg to relieve the initial shock and assist the governor in regulating speed. As previously mentioned, speed is regulated by the governor changing the pitch angle of the blades into the wind. Change in blade-pitch angle for normal operation will be about 30 deg, but a range of 99 deg has been provided for research purposes.

Two double roller bearings 12 ft apart on the pintle girder support the turbine shaft, which is about 24 in. in diameter. The bearing just back of the turbine hub is a radial unit and that at the coupling for the speed-up gears takes both axial thrust and radial loads. The turbine shaft couples to a double-spur-and-herringbone-gear unit that increases its speed to 600 rpm, that of the generator. First step of speed increase is taken by a spur gear meshing into a pinion on either side of it in the horizontal plane. These pinions are on the shaft of two herringbone gears that mesh into the pinion on the output shaft. This shaft connects through an American Blower hydraulic coupling to the generator shaft. Beyond the generator is a direct-connected exciter. A standard Woodward speed governor with some electrical contacts added is gear driven from the turbine shaft.

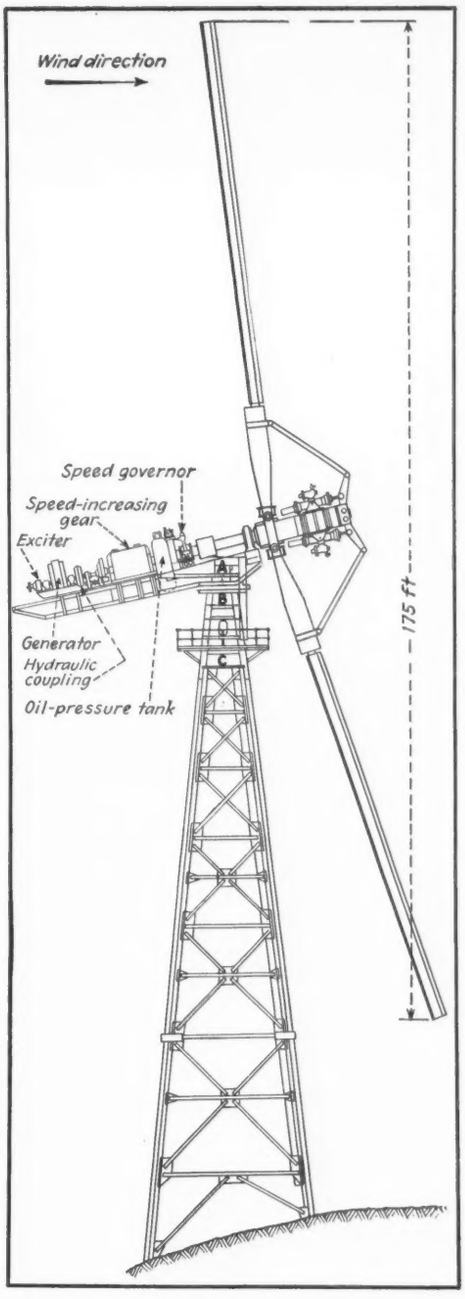


Fig. 2—The entire plant is built on a heavy structural-steel pintle girder on top of a 110-ft tower anchored into the mountain top by a heavy steel and concrete foundation

On the output-gear shaft, between the gear case and hydraulic coupling a friction clutch gears into a motor-driven turning device equipped with a brake. When the unit is shut down the clutch can be closed and the brake on the turning device applied to prevent the turbine from turning. The turning device will also serve to put the turbine rotor in any desired position when the unit is shut down.

At all times the unit is held with the turbine down wind by a bull gear fixed in the top of the tower just below the pintle girder. The bull gear connects to

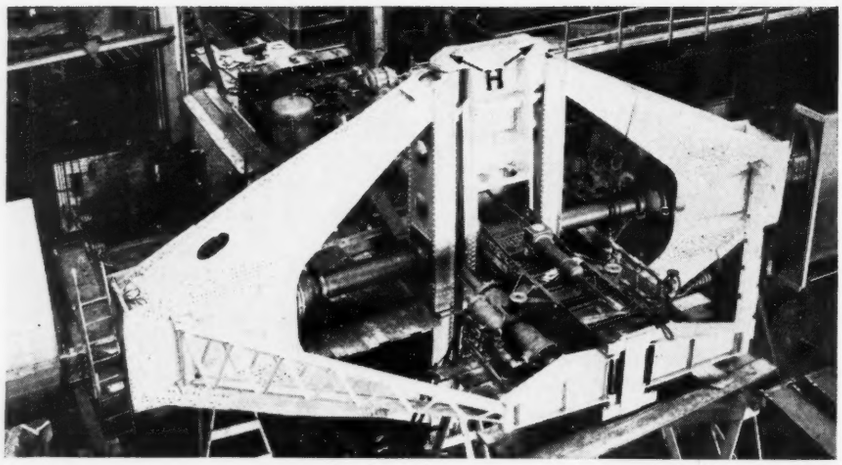


Fig. 3—Each blade, weighing 15,300 lb, is supported by its shank from the hub-post by a heavy structural-steel A-frame hinged at *H*

gearing on the pintle girder, driven by a Waterbury hydraulic transmission and is controlled by a yaw meter (wind-direction vane) mounted on the housing that will enclose the power-transmitting and generating equipment on the pintle girder.

The generator, built by the General Electric Co, is rated 1000 kw at 80% power factor, 2300 volts, 60 cycles, 3 phase. Leads from the generator are taken down through the center of the pintle shaft and connect to slip rings supported on a hollow slip-ring post. This post is an extension of the pintle shaft about 10 ft long, with its lower end supported in a guide bearing. Brushes on these slip rings connect to cables that lead to a transformer bank where the voltage is stepped up to 44,000 volts for connection to the transmission lines of the Central Vermont Public Service Corp.

Test and Control Circuits

Conductors for the great number of test and control circuits on the power-plant equipment also come down through the pintle shaft and connect to rings on the slip-ring post. Brushes on the rings lead to the power-plant research laboratory and control room, housed in a heavy steel and concrete building about 200 ft away from the plant tower.

It is expected that satisfactory winds will be available to operate the unit about 4000 hr per yr, about 2700 hr of which will be at full load. This is on the assumption that the unit will go into service when the wind reaches a velocity of 18 miles per hr and off at wind velocities above 60 miles per hr. It is estimated that a wind velocity of 4 miles an hour will cause the turbine to rotate. A wind of 18 miles per hr is expected to operate the turbine at a small percentage of rated capacity and normal speed. Because of the uncertain velocity of the wind it is at this time considered not advisable to operate the unit at much less than 25% load. Experience may show that safe operation can be had at lower loads.

Control of the station will be entirely automatic using very much the same equipment as in automatic hydro electric plants. Starting and stopping of the unit will be by wind velocity.

The installation, being the first of its kind, is admittedly experimental. It is built on a scale large enough to test the feasibility of such units for utilizing the winds for power generation, where the annual winds are sufficient to make such installations economical. In addition to designing the unit for commercial power generation, engineers here incorporated in it practically every device necessary for exhaustive study of its performance. The designers are pioneering in a field where fundamental knowledge and practical operating experience are lacking. Therefore, when they were in doubt they provided against every possible emergency they could think of.

Parallel Operation

This is the first attempt at regulating a wind-driven alternating-current generator operating in parallel with a public-utility system. Steam at turbine and engine throttles is held at constant pressure and water to water-wheels flows under a practically constant head or, at worst, with a slowly changing head. On the other hand, wind velocity and direction may change very suddenly; consequently, experience in governing steam turbines and waterwheels is of little account when applied to wind turbines.

The unit has unusually high unit inertia ($WR^2 \times (RPM)^3 \div Hp$), several times that of the average hydroelectric unit, and should therefore be exceptionally stable in its operation. The only way that this characteristic can be obtained in a wind-power unit is by building in a heavy flywheel or building units of comparatively large sizes. All studies made of the problem indicated that the solution of speed regulation of wind turbines is inherently associated with large-size units. For this reason a 1000-kw machine is being installed instead of a small experimental unit that might not give the desired answers.

Even though the unit has very high unit inertia and should be very stable in operation it is difficult to predict what will be the effects of sudden changes in wind direction and velocity combined with abrupt load changes. Sudden gusts of wind alone might so overload the generator that it would pull out of step. The hydraulic coupling has therefore been installed to act as a slip connection and prevent sudden overloads. If this coupling is found unnecessary it may be omitted from future designs.

Wind and Water Power

The unit will deliver power to a system supplied largely by hydroelectric plants. Wind and water power differ in several respects: Where reservoir capacity is available water can be stored during the flood period for use when flow is low. Wind cannot be stored and must be used when available like water on a river without storage. Water flow from a given area, like wind, varies widely during any one year. However, water flow also varies widely from year to year, as does the amount of power you can generate from it, while the amount of wind is fairly constant. Therefore, even though the output of a wind-power plant may vary from zero to its full capacity, the kilowatt-hours it can generate in any one year are more constant than from most water-power plants.

However, wind-power plants like this one must always operate in parallel with another source of power, such as a water-power plant with storage or a steam plant. They will probably be built in comparatively small units, of at most a few-thousand kilowatts capacity. In a national defense program this will be an advantage, because a bomb dropped on a large wind-power installation could cripple probably not more than one unit. If the same bomb fell into a 500,000-kw steam plant, it might shut down the whole plant for a long period.

Before a hydroelectric project can be intelligently engineered, complete knowledge of hydrology of the drainage area must be available. When this

wind-power project was conceived little was known about wind characteristics at possible sites for aeroelectric plants. During the last five years much study has been given to this part of the problem by Mr Putnam and his associates. On top of some mountains the wind is very turbulent, while on others it blows in a fairly horizontal direction. Other conditions being equal, steady horizontal flow is preferable.

In certain temperate climates ice is an important consideration. For the plant under discussion there are better sites for it from wind considerations, but the ice conditions in winter are likely to be much worse than on Grandpa's Knob; therefore it was selected to reduce risk from ice for the experimental plant.

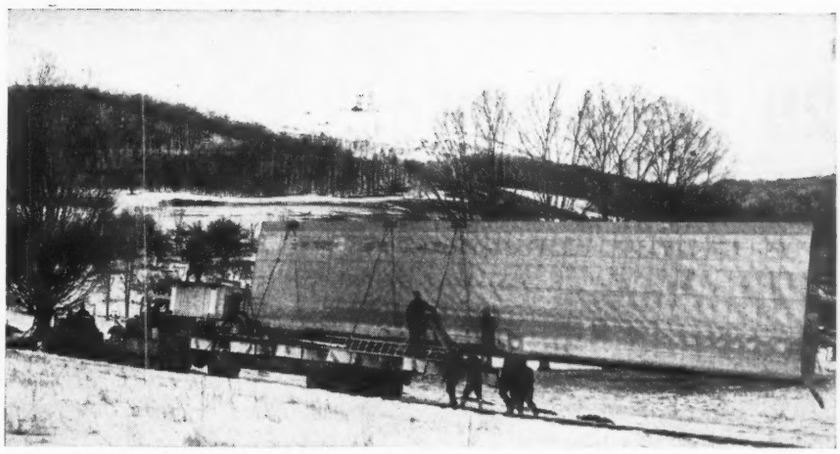


Fig. 4—One of the stainless-steel blades, 65 ft long and over 11 ft wide, on its way to Grandpa's Knob, which can be seen in top center with the tower under construction

Palmer Cosslett Putnam, who invented and worked out the general design of the wind turbine, first began to study the problem of wind power in 1935. At that time he came to the conclusion that all previous wind-power units had been built on too small a scale to be constructed at an economical unit cost and also that their unit inertia was too low for satisfactory speed regulation. Preliminary studies made at the suggestion of Dr Vannevar Bush, then Dean of Engineering, Massachusetts Institute of Technology and now President of Carnegie Institution, Washington, D. C., verified these conclusions. Dr Bush suggested to T S Knight, vice-president, General Electric Co, that the project should be worked up in detail and Mr Putnam then made the general design.

In 1939, Mr Knight interested Beauchamp E Smith, vice-president and general manager, S Morgan Smith Co, who assumed financial responsibility for the project. Walter S Wyman, president, New England Public Service Co, also became interested and made available the power system of the Central Vermont Public Service Corp as the guinea pig onto which the project could be connected.

Before deciding on the final design, models were built and these were tested by Professor Elliott Reid in the wind tunnel of Stanford University, under the direction of Theodore von Kármán, director of the Guggenheim Aeronautical Laboratories, California Institute of Technology. Dr John B Wilbur, director of the Structural-Analysis Laboratories at Massachusetts Institute of Technology, is chief engineer of the project. Palmer Cosslett Putnam is aeroelectric consultant and project engineer.

Joseph S Newell, Professor of Structural Aeronautics at Massachusetts Institute of Technology, was responsible for the turbine-blade structural design. With the exception of the tower all structural steel work, the pintle and main shafts and the shop assembly of the unit was done by Wellman Engineering Co. Engineering for the cooperating utility-system company is being done by the Nepsco Services, Inc, Augusta, Me.

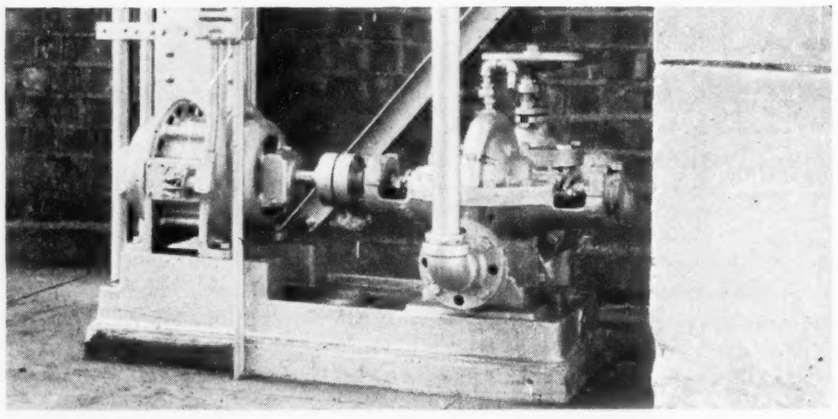
Fig. 5—The blades are like airplane wings in cross-section and are attached to a heavy shank shaft supported in two roller bearings

Vision and Courage

The technical and economic possibilities of fuel and water-power developments have been pretty well explored, but the Grandpa's Knob project is the first attempt to harness the wind for electric-power generation on a commercial scale. Those who have made this tremendous research project possible are entitled to great credit for having the vision to explore this new field of power and for having the courage to back their convictions to the limit with their time, their energy and their financial resources. Here is another example of unfettered individual initiative that has made America great and will continue to make her so as long as given free rein.

20 Cents a Week Protects Standby Boiler

H M Naylor, Kansas Power & Light Co, presents a solution to a longstanding problem of how to prevent corrosion in emergency reserve boilers. Here, he explains and gives results on a home-made circulating system for chemically treated water which does the job at very low first cost and running expense



Forced circulation throughout cold boiler assured by small motor-driven pump

▶ To CARRY STANDBY BOILERS with a high degree of availability without excessive banking cost is a dilemma faced by many central-station operators as well as industrial engineers. Dissolved-oxygen corrosion must be prevented at all costs. Demand for continuity of service requires the plant chief to adopt operating procedures that fulfill the corrosion-prevention requirement at a minimum of operating expense and maintenance.

These procedures are far from uniform. Where continuity of service is not vital, perhaps the best way is to empty the boiler, uncap it, dry it out and put trays of deliquescent chemicals inside to keep it so. Of course, a boiler thus laid up would scarcely be classed as "standby" since it could not be made available in less than several hours, depending on its type and size. It does, however, require no fuel, and maintenance costs are negligible.

Boiler "Capped Up"

An alternative, sometimes used, is to carry the boiler capped up, filled to operating level, and fired to keep sufficient pressure to insure no air being drawn in. The writer employed this method for two years, with excellent results from availability and maintenance standpoints, but with much to be desired in operating expense.

Gas-fired boilers (400-lb pressure) were carried from 50 to 100 lb, and in emergency could be on the line in 20 minutes. Moderate firing for 30 to 40 minutes once each 8-hr shift was required to hold this pressure. However, freedom from oxygen pitting obtained with sodium sulphite could not be assured without putting the boiler on the line about four hours once a week, for analyzing boiler water and adding chemicals if necessary.

One of the most important factors in weekly operation of the boiler was vigorous agitation and circulation of the boiler water. Adequate circulation is not only vital in the operation of a boiler, but is also important in preventing oxygen pitting in standby boiler units.

Regardless of the chemical used for control of entrained oxygen, and largely irrespective of its concentration, quiescent or sluggishly circulated boiler water suffers the chance that some remote point in the system may lack chemicals. At the same time water in other parts of the boiler may still show a satisfactory concentration. For this reason, water samples taken under standby conditions are next to useless as a means of checking the condition of the boiler.

Maintaining some pressure, while providing a high degree of availability, consumes an appreciable amount of fuel, and preservation of the boiler structure necessitates close watching, frequent actual operation, and rigid control. A further objection to periodic operation is that the boiler delegated to the role of "standby" is frequently an older, less efficient unit, and the more it can be kept out of actual service, the better will be the over-all boiler-room efficiency.

Another alternative requires filling the boiler with water and letting it stand until needed. When the need arises, water is drained down to operating level. With modern boilers, especially with gas, oil, or pulverized coal, this can be done in surprisingly short time. While not recommended for regular practice, the boiler *can* be on the line in an hour or less, depending on its size, type, and fuel. This alternative, in its simplest form, combines desirable features as to fuel consumption and a reasonable degree of availability, but leaves much to be desired in the matter of corrosion prevention.

For several years sodium sulphite has been used in preventing oxygen corrosion in steaming boilers. At least one recent attempt was made by an electric utility to use sulphite in standby boilers. This attempt was not successful, and its failure was attributed to lack of water circulation and uniform concentration.

In this case sodium chromate was then substituted for the sulphite. One of the vital factors in the chromate method is the forming of a "*continuous* impermeable film *in close contact with the metal.*" This would seem to presume a *perfectly* clean boiler, a thing very difficult to secure after appreciable service. Scale breaks the vital continuity of the film.

The investigators feared that circulating and agitating the boiler water to prevent oxygen corrosion with sodium sulphite would result in prohibitive expense. While the writer was and still is not familiar with all the local factors, several years successful experience with sodium sulphite in working boilers seemed to indicate that this conclusion was at least open to question. Accordingly, some investigations were under-

taken in an attempt to discover if a standby boiler could be carried safely with a reasonable degree of availability at minimum fuel and chemical expense.

The plant under the writer's supervision is equipped with five single-drum, straight-tube, sectional-header boilers, each having 12,520 sq ft heating surface. All are equipped with interdeck superheaters, economizers and water walls, and are gas fired. All but the most recent units have been converted to gas firing from chain-grate stokers.

Recent installation of individual fuel meters on these boilers disclosed that it was requiring approximately 1% of the total plant fuel to maintain 50 to 100 lb pressure on the standby boiler. Steps were taken at once to save this fuel expense without sacrificing too much availability, and none at all, if possible, on corrosion prevention.

Scaled Boiler Selected

The least efficient boiler was selected for this purpose; it still has the old suspended arch from coal-firing days. The other stoker-fired units have had the arches replaced by straight refractory walls. Further, this boiler still has clinging to it in spots (but slowly disintegrating as time passes) a small amount of hard scale, the result of a bad job of water treating several years ago. This scale is too hard for effective removal with turbine or wire brush. Because of this, the chromate treatment seemed automatically ruled out.

This arrangement, Fig. 1, of boiler-feed lines, economizer, boiler and water-wall blowdown connections and superheater drains, was such that a simple installation of two sectionalizing valves and a tee in the blowoff main, the welding in of a 2-in. connection in the feedwater line with a high-pressure shut-off valve, and the running of a few feet of pipe were all that was necessary to connect up a small centrifugal pump driven by a 5-hp motor. All piping and fittings, with the exception of the high-pressure valve and welded-in nipple, were 125 lb standard, since they are never opened to the boiler circulating system under normal pressure.

The pump took four hours to move the entire volume of water through one circulation cycle. The number of consecutive cycles required and the time interval between periods of circulation were later settled by trial and error.

Preliminary estimates as to the amount of sulphite necessary for the initial charge followed an adopted standard in this plant for working boilers of a minimum of 7 grains per gallon. Estimates showed approximately 15,000 gallons of water would fill the boiler

TABLE I—DRUM VENT OPEN

Date	*Time*	*Sodium sulphite, gr/gal*	*Drains open*
Jan. 30	2:05 PM	4.7	All
" 30	2:20	4.7	"
" 30	2:30	4.4	"
" 30	2:40	4.1	"
" 30	2:50	4.0	"
" 30	3:00	3.4	"
" 30	3:10	3.0	"
" 30	3:20	3.2	"
" 30	3:30	3.0	"
" 30	3:40	3.0	"
" 30	3:50	2.7	"
Circulation stopped for day.			
Circulation resumed			
Jan. 31	10:30 AM	2.4	All
" 31	10:45	2.6	"
" 31	11:00	2.4	"
" 31	11:15	2.3	"
" 31	11:30	2.4	"
" 31	11:45	2.3	"
" 31	12:00 Noon	2.3	"
" 31	12:15 PM	2.1	"
" 31	12:30	2.4	"
Began feeding 10 lb sulphite to water entering economizer.			
Jan. 31	12:45	2.4	All
" 31	1:00	2.2	"
" 31	1:15	2.9	"
Sulphite all in boiler.			
Jan. 31	1:30	3.6	All
" 31	1:45	3.6	"
" 31	2:00	4.2	"
" 31	2:15	4.0	"
" 31	2:30	4.2	"
" 31	2:45	4.2	"
" 31	3:00	4.2	"
" 31	3:15	3.9	"
" 31	3:30	4.1	"
" 31	3:45	4.1	"

TABLE II—DRUM VENT OPEN

Date	*Time*	*Sodium sulphite, gr/gal*	*Drains open*
Feb. 2	8:00 AM	0.5	All
" 2	8:15	0.4	"
Began adding 20 lb sodium sulphite at 8:20 AM			
Feb. 2	8:30	0.4	All
" 2	8:45	7.5	"
20 lb sodium sulphite all in at 8:55 AM.			
Feb. 2	9:00	12.4	All
" 2	9:15	11.8	"
" 2	9:30	12.6	"
" 2	9:45	11.8	"
" 2	10:00	13.6	"
" 2	10:15	13.0	"
" 2	10:30	13.0	"
" 2	10:45	13.0	"
" 2	11:00	13.0	"
" 2	11:15	12.6	"
" 2	11:30	12.6	"
" 2	11:45	12.2	"
" 2	12:00 Noon	12.4	"
" 2	12:15 PM	12.4	"
" 2	12:30	12.6	"
" 2	12:45	12.8	"
" 2	1:00	12.6	"
" 2	1:15	12.2	"
" 2	1:30	12.4	"
" 2	2:00	12.0	"
" 2	2:30	12.2	"
" 2	3:00	12.4	"
" 2	3:30	12.0	"
" 2	3:55	11.4	"
Circulation pump shut down at 4:00 PM			

TABLE III

Date	*Time*	*Sodium sulphite, gr/gal*	*Drains and blowdowns open*	*Remarks*
Feb. 3	8:00 AM	11.0	All	
" 3	8:30	11.4	"	
" 3	9:00	11.2	"	
" 3	9:30	10.2	"	
" 3	10:00	10.8	E	Opened at 9:40
" 3	10:30	10.6	E	
" 3	11:05	10.6	J	Opened at 10:35
" 3	11:30	11.2	H	Opened at 11:06
" 3	12:00 Noon	10.8	K	Opened at 11:35
" 3	12:30	10.4	G	Opened at 12:05
" 3	1:15	11.6	F	Opened at 12:35
" 3	1:45	11.0	C	Opened at 1:20
" 3	1:55	10.0	D, L, and C	Opened at 1:50 (C left open by mistake)
" 3	2:30	10.0	D, L, and C	(C discovered open, closed at 3:01)
" 3	3:00	9.4	D and L	
" 3	3:40	8.4	D and L	
" 3	3:45	....	None	Pump shut down

TABLE IV

Date	*Time*	*Sodium sulphite, gr/gal*	*Drains and blowdowns open*	*Remarks*
Feb. 6	8:30 AM	....	D and L	Circulation started.
" 6	12:30 PM	8.2	D and L	
" 6	12:45	8.3	D and L	
" 6	3:10	8.3	D and L	
" 6	3:45	10.2	C	D and L closed and C opened at 3:15.
" 6	3:47	....	None	Pump shut down.

TABLE V

Date	Time	Sodium sulphite, gr/gal	Drains and blowdowns open	Remarks
Feb. 14	12:30 AM	....	All	Circulation started.
" 14	10:10	9.3	"	
" 14	11:00	9.4	"	
" 14	12:05 PM	9.4	"	
" 14	1:10	9.2	"	
" 14	2:10	9.3	"	
" 14	3:15	9.1	D and L	All valves but D and L closed at 2:15 PM.
" 14	3:45	....	None	Pump shut down.

TABLE VI

Date	Time	Sodium sulphite, gr/gal	Drains and blowdowns open	Remarks
Feb. 27		9.3	All	Circulated from 10:00 AM till midnight.
Feb. 28		9.0	"	Circulated from midnight till 1:30 PM.
Mar 15		7.5	"	Circulated twelve hours.
Apr. 1		5.7	"	10 lb. sulphite added, 9.5 gr per gal afterward.
Apr. 3		9.4	"	Circulated twleve hours.

TABLE VII—107 WEEKS' LOG

(All drains open when boiler down)

Date	Sodium sulph, gr/gal	Remarks
April 7, 1939		Boiler fired up for use while other boilers were taken down for semi-annual overhaul and inspection.
May 30, 1939		Boiler off line for inspection following completion of work on other boilers. Inspection revealed boiler in satisfactory condition. No oxygen pitting.
June 10, 1939	7.5	Boiler superheater and economizer filled and returned to emergency reserve. 20 lb. sodium sulphite added.
June 12, 1939	7.5	10 lb. sodium sulphite added.
June 13, 1939	16.8	After adding 15 lb. sodium sulphite.
June 13, 1939 to Sept. 15, 1939	16.8 to 13.4	During this period the water was circulated once a week and tested. During entire period no further chemicals were added.
Sept. 16, 1939		Boiler steamed up for use during overhaul of other units.
Nov. 19, 1939		Boiler opened up for inspection. Condition satisfactory.
Nov. 29, 1939		Boiler returned to emergency reserve.
Nov. 30, 1939	10.4	20 lb. sodium sulphite added.
Dec. 4, 1939		Boiler steamed up and on line in 70 min. Could have been pushed faster. An emergency start to cover suddenly developed fault in one of the other boilers.
Dec. 9, 1939		Boiler off line.
Dec. 12, 1939	4.7	Boiler cooled off, refilled and returned to reserve.
Dec. 12, 1939	9.2	6 lb. sodium sulphite added.
Jan. 15, 1940	6.9	Concentration below minimum.
Jan. 15, 1940 to Mar. 23, 1940	10.6 to 9.8	6 lb. sodium sulphite added. Boiler steamed up for use during overhaul of other units.
June 15, 1940		Drained and opened up for inspection. Perfect condition.
July 5, 1940	10.5	20 lb. sodium sulphite added after refilling boiler and returning to emergency reserve.
Aug. 12, 1940	7.3	
Aug. 19, 1940	9.9	After adding 6 lb. sodium sulphite.
Sept. 22, 1940	9.1	Boiler steamed up for use during overhaul of other units.
Oct. 30, 1940		Boiler off line, cooled, refilled, and returned to reserve without being drained and opened up for inspection. The latter to be done at next semi-annual inspection, giving one whole year (approx.) under cold-storage condition.
Nov. 6, 1940	10.8	After adding 15 lb. sodium sulphite.
Nov. 25, 1940	7.4	
Nov. 25, 1940	10.0	After adding 6 lb. sodium sulphite.
Dec. 13, 1940	9.0	Concentration down after refilling economizer which had been emptied for minor repairs, and then refilled.
Mar. 17, 1940	7.9	Boiler drained, opened up and inspected prior to being put in service during semi-annual overhaul of other units. No evidence of oxygen pitting. Appearance of all other water surfaces satisfactory.

tubes, drum, saturated steam line, economizer, water walls, headers, and all accessory piping. On this basis, a concentration of 7 gr per gal would require 15 lb of sodium sulphite for a completely fresh charge of water. If the water, left in the boiler coming off the line, contained any residual sulphite, the amount required would be proportionately less.

It should be noted that the standby circulation system of Fig. 1 provides not only for circulation of the water in the boiler proper, but in the economizer, water walls and superheater as well. It is just as important, if not more so, to protect the three latter as the first, since they are just as susceptible to damage as the boiler, while their internal condition can not be as readily and effectively observed.

Investigation Procedure

Accordingly, we arranged the investigation procedure to discover if, with all blowdowns and superheater drains open, each delivered its pro-rata share of the water taken in at the pump suction; or if pipe friction in any specific connection might be so high that the reduced flow would rob that portion of the boiler or its accessories of circulation. At the rate of circulation employed, it was considered quite improbable for pipe friction to cause any marked departure from a proportional flow. Also, along with this phase of the investigation we expected to discover if any given zone of the boiler might be especially active in reducing the sulphite concentration.

Prior to the beginning of the tests the boiler had been carried for some weeks under the reduced pressure method. Fires were first turned out and the boiler was allowed to cool off for several days. It was then filled completely including the saturated-steam line and superheater. With the drum vent open the pump was started and run for two hours. Samples were drawn and tested at 10- or 15-minute intervals from the pump casing and the results logged to determine when a stable concentration had been reached, that is, all free oxygen accounted for (see Table I).

This boiler had been operated for three hours about nine days previously at which time the sulphite concentration had been adjusted well above the 7-grain minimum. The low initial concentration of 4.7 gr per gal indicates the dangerous rapidity at which the sulphite may be oxidized even in a standby boiler carried at reduced pressure. This is another way of saying that oxygen is carried into a boiler quite rapidly along with additional water that must be

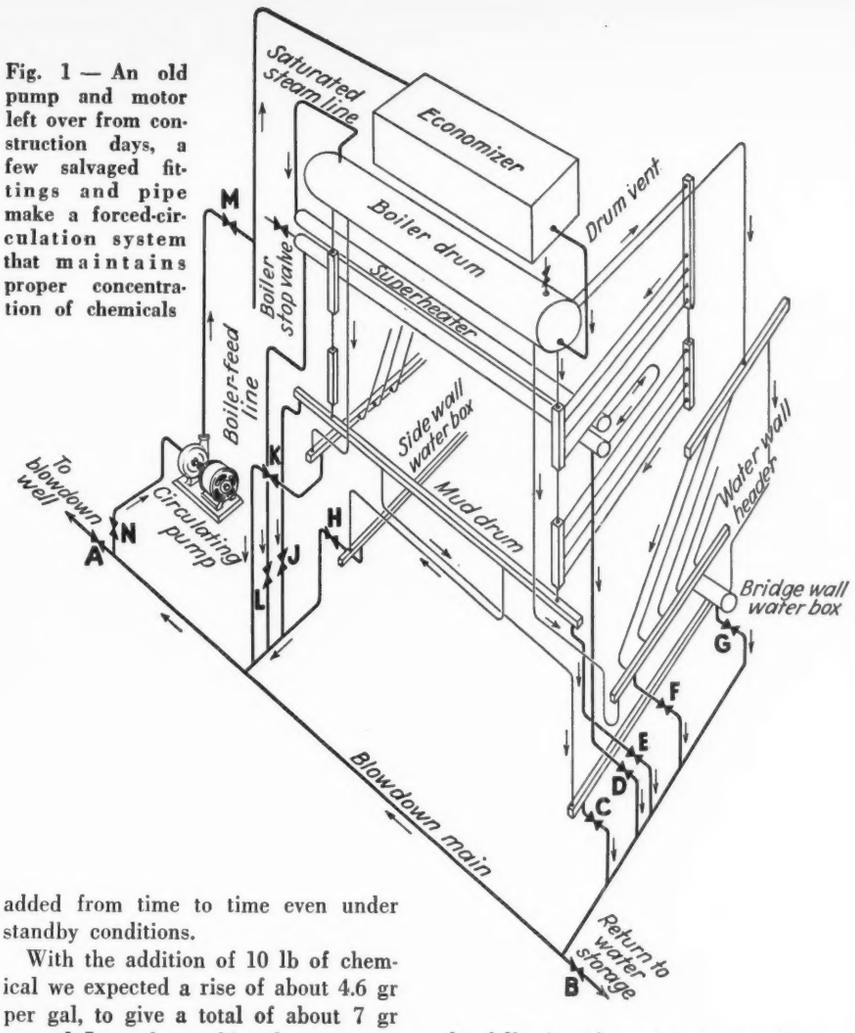


Fig. 1 — An old pump and motor left over from construction days, a few salvaged fittings and pipe make a forced-circulation system that maintains proper concentration of chemicals

added from time to time even under standby conditions.

With the addition of 10 lb of chemical we expected a rise of about 4.6 gr per gal, to give a total of about 7 gr per gal. Instead we achieved an increase to only about 4.1 gr per gal, with about 3 gr per gal unaccounted for. Either our estimates on the volume of water in the system were much too low or else we were drawing in air. Pump-shaft packing and the open drum vent were two possible sources. Candling the pump packing eliminated one of the two sources and the drum vent was kept closed during all subsequent work except when adding water to the boiler.

Pressure of other matters halted the work for a day. In the meantime it was necessary to drain the boiler almost completely. With nearly an entire boiler-full of fresh water on resumption of tests, a low initial value of 0.5 gr per gal of sulphite was to be expected. Under these circumstances the addition of 20 lb of sulphite was begun at once, this quantity being expected to give a safe excess concentration over the 7-gr-per-gal minimum.

Table II logs the next series of data. In this run, with the drum vent closed, 20 lb of sulphite was expected to give about 9.33 gr per gal rise; instead it gave somewhat more, confirming the conclusion that the drum vent being open during circulation needlessly depleted the concentration of chemical.

The data in Table III was obtained the following day after having begun circulation of the water at 4:00 AM, thus providing one complete circulation cycle before starting to collect data. In addition, at 9:40 AM, circulation was altered for the balance of the day so that water was drawn from the boiler for short periods, from each of several blowdowns and drain valves. In each case, all other drains were closed. Water samples were taken and analyzed at each change in circulation.

This data was intended to show if pro-rata circulation existed through all blowdowns and drains. Fig. 1 shows location of blowdown and drains open in each case. Analysis discloses little variation throughout the boiler except when circulated through the superheater alone. Here the concentration dropped excessively.

After letting the boiler stand for three days a short test was made to verify the drop in concentration in the superheater. This data, Table IV, indicates that concentration in the superheater did not equalize with the rest of the boiler.

The highest point in the circulation system of the boiler (not including the economizer) is the saturated-steam line. It was thought probable that the water drawn off for tests, see Table III, was sufficient to lower the water level in the boiler below the invert of the saturated-steam line. Since circulation system was closed tightly, this air-bound space did not fill up from economizer above to permit circulation through superheater.

With this in mind, another test was run eight days later, after adding additional water to fill the saturated-steam line, but adding no sulphite. We observed at once that circulation through the superheater alone showed essentially the same concentration of sodium sulphite as the rest of the boiler. If the boiler is entirely full of water and no air bound traps exist, the total water entering the pump suction will be composed of pro-rata amounts from each of the various blowdowns and drain connections. Further verification was obtained in a later test Feb 27.

We further observed that the concentration had dropped from an average of about 10.5 gr per gal on Feb 3, Table III, to about 9.3 gr per gal on Feb 14. How much of this decrease was due to the fresh water added and how much to continued oxidation between tests was open to question. Table VI shows the results of subsequent periodic checks to determine the rate at which the sulphite oxidized. These appeared sufficiently definite to justify continuing the practice over an extended period.

Routine Schedule

We accordingly adopted a routine schedule of circulating the water for 12 hours once each week, at the same time testing a sample of the water as drawn from the pump casing, and adding sodium sulphite whenever the test showed the concentration approaching 7 gr per gal. Table VII gives a condensed log of weekly observations extending over two years. The elapsed time from Feb 1939 to March 1941 included 107 weeks. Of this period, the boiler was in service 35 weeks, open for inspection 6 weeks, and in emergency reserve 66 weeks. 134 lb of sulphite were required during reserve periods, an average of 2 lb per week.

This method of carrying an emergency reserve boiler has proved satisfactory, having maintained water and steam surfaces free of oxygen pitting and other corrosion. A weekly circulation period of 12 hours is sufficient to maintain proper concentration and good distribution of the chemical.

The cost of chemicals and power for operating the circulating pump is so small as to be negligible. Sodium sulphite at four cents per lb and pumping energy at one cent per hr switchboard cost adds up to a *total weekly cost of 20 cents* for protecting the boiler.

Bearing Lubrication of Reciprocating Air

The article "Lubricating Cylinders of Reciprocating Air Compressors," March POWER, received the highest vote in our monthly reader poll, proving the popularity of both the subject and the author, one of the real experts in this field. Here he rounds out the job by pointing out the various factors of bearing lubrication that insure efficient compressor operation

By JAMES I CLOWER
Associate Professor of Machine Design, Virginia Polytechnic Institute

▶ BEARINGS OF RECIPROCATING AIR COMPRESSORS are generally oiled by a splash, gravity - circulation, force - circulation, ring or chain, drop-feed or wick-feed system. In some instances combinations of two or more of these methods are used.

The splash method, generally used to lubricate all parts of small single-acting compressors, is also widely used for solely the bearings of many horizontal double-acting machines, the cylinders of which are supplied by mechanical force-feed or so-called pressure drop-feed lubricators.

Because the crankcase of splash-lubricated compressors generally serve as oil reservoirs or sumps, they are closed except for a breather or vent pipe. The cylinder and crankcase of compressors having splash-lubrication for the bearings only are usually provided with a bulkhead equipped with oil-wiper rings as at *O*, Figs. 3 and 4, that prevent crankcase oil from working along the piston rod into the cylinder. These oil-wiper rings should be kept in first-class mechanical condition.

It is very important, also, to maintain correct oil level in the crank case.

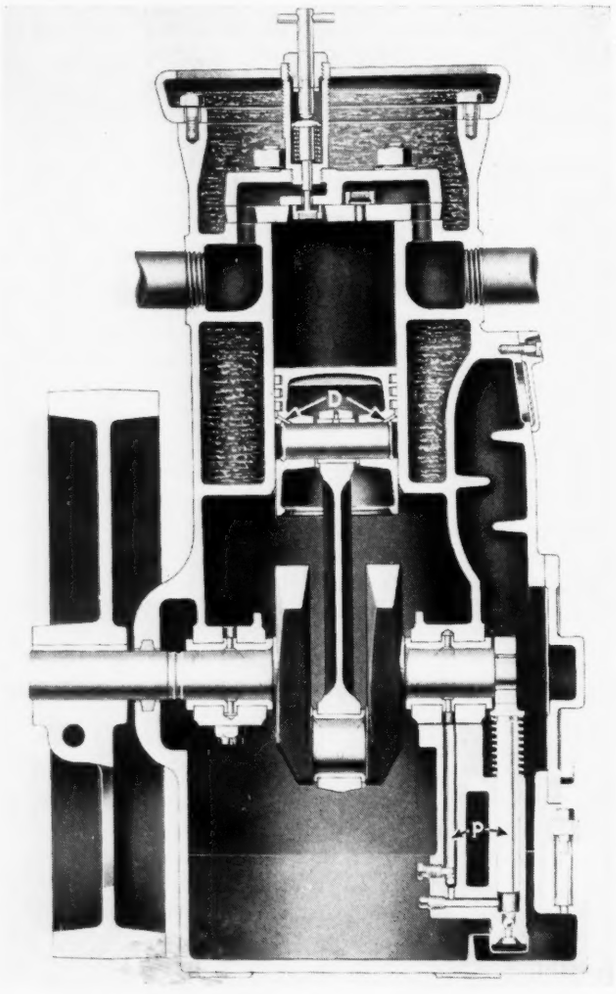


Fig. 1—Water-cooled, single-acting vertical air compressor has bearings pressure-lubricated by pump *P* in the oil reservoir

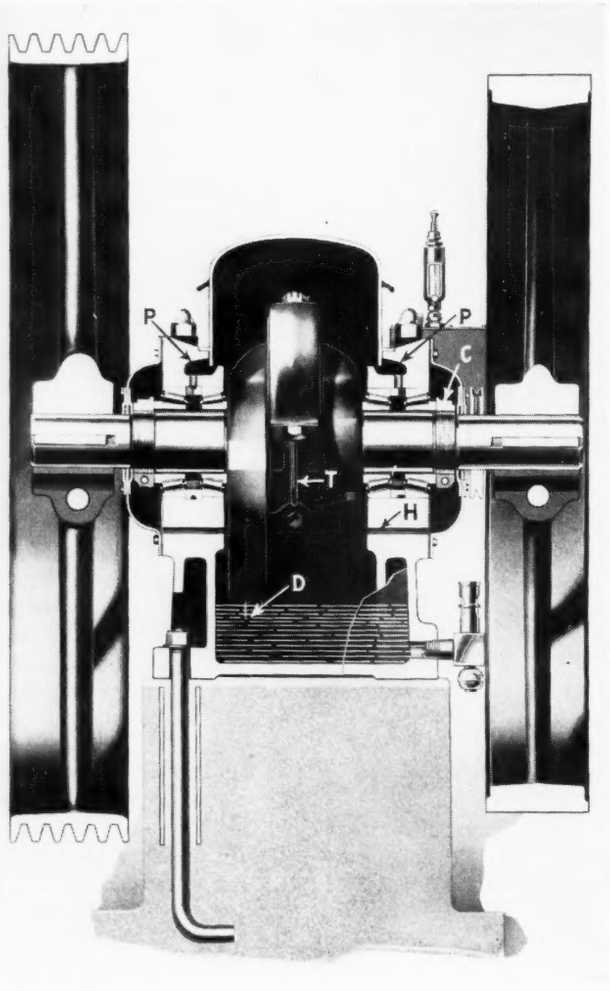


Fig. 2—Traverse section through splash-lubricated compressor, Fig. 4. Oil pockets *P* lubricate roller crank-shaft bearings

If the oil level is carried too high, excessive oil is likely to pass into the cylinder, thus causing high oil consumption and formation of troublesome carbon deposits. Too high an oil level also accelerates degradation of the crankcase oil by whipping excessive air into the oil. On the other hand, if the oil level is carried too low, the bearings may not receive sufficient lubricant. Modern splash-lubricated compressors, however, are equipped with a system of troughs and partitions so arranged to insure correct oil level.

Crank-Shaft Bearings

Fig. 2 is a cross-section through the crankshaft bearings of the compressor, Fig. 4. The tapered-roller crankshaft bearings, Fig. 2, are lubricated by oil splashed into pockets *P*, from where it flows down into the bearing to flood lubricate them, then back into the reservoir. Oil flowing to the outside of the bearings is prevented from leaking along the shaft by oil slingers and collectors *C*. This oil flows back into the reservoir through a hole *H*. Tubular scoop *T* provides positive lubrication to the crank-pin bearing. Crank counterweight dipper *D* picks up oil from the reservoir and discharges it into pocket P_1 from where it flows through the pipe P_2 to lubricate the crosshead-pin bearing and guides, Fig. 4.

In the gravity-circulation system, oil is pumped from a bottom tank or sump to an overhead reservoir from where it flows to all bearings through pipes equipped with feed-regulating valves. The regulating valves are recommended so that the feeds can be adjusted to the requirements of individual bearings.

Characteristics of Reciprocating-Air-Compressor Bearing Oils

Operating Conditions			*Viscosity, SUS*		
Bearing temperature, F	*Speed, rpm*	*Method of lubrication*	*100 F*	*130 F*	*210 F*
Below 140	Below 300	Circulation	220	110	47
		Splash, ring, drop-feed, wick-feed	310	145	52
	Above 300	Circulation	155	85	43
		Splash, ring, drop-feed, wick-feed	220	110	47
Above 140	300	Circulation	425	195	58
		Splash, ring, drop-feed, wick-feed	570	250	65
	Above 300	Circulation	310	145	52
		Splash, ring, drop-feed, wick-feed	425	195	58

Force-Circulation Oiling

In the force-circulation system, a flood of oil is pumped under a pressure of 15 to 10 lb directly from a reservoir to all bearings, Figs. 1 and 3. The oil returns to the sump by gravity.

In Fig. 1, a reciprocating pump *P* forces oil from the reservoir up under the center of the right-hand crankshaft bearing to lubricate this bearing and through oil ducts in the crankshaft to the crankpin and left-hand crankshaft bearings. The oil pump is driven from the right-hand end of the crankshaft. The wrist-pin bearings are lubricated from cylinder walls through ducts *D*.

On the horizontal compressor, Fig. 3, a chain-driven rotary gear pump takes oil through a strainer from a reservoir below the crankshaft bearings. The oil is pumped to the crankshaft and crosshead-pin bearings and crosshead guides in both the low- and high-pressure side of the compressor. On its way to the bearings the oil passes through a filter and cooler to insure a clean cool oil supply to the bearings. A pressure switch connected into the oil line shuts down the compressor in case of oil-pressure failure, to prevent overheating of the bearings from lack of lubricant.

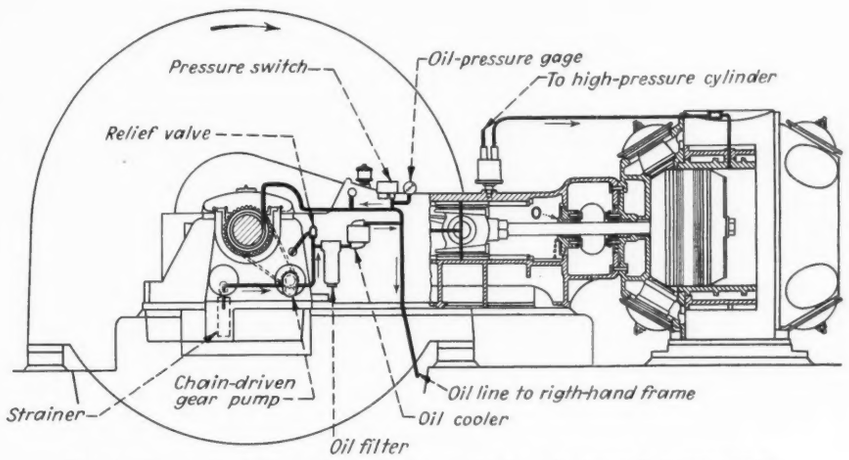


Fig. 3—Force-circulation oiling system as used on horizontal, 2-stage units

Oil Required

Both the gravity- and force-circulation system may be equipped with an oil filter, or cooler, or both, as in Fig. 3. Gear, vane, and plunger-type oil pumps are used. Invariably the oil pump is driven by the compressor itself. The quantity of oil in the system depends, of course, on the capacity of the compressor. It should be sufficient, however, to permit the oil to remain quiescent for a period of time each cycle, thus permitting impurities and water to settle.

Circulation oiling is a reliable and economical method of lubricating the bearings of air compressors. Drop-feed and wick-feed oiling are restricted to minor bearings and parts not subjected to heavy loads.

Because it is used repeatedly, oil in circulation, splash, and ring systems must, in addition to correct viscosity, possess high resistance to oxidation and emulsification. Oil fed from drop-feed cups is used but once and passes rather quickly through the bearings to waste. In drop-feed cups the oil is

not churned nor agitated and does not come into contact with water. Consequently, it need not be highly resistant to oxidation and emulsification.

Single-Acting Compressors

In most single-acting compressors, one oil is required to serve both the bearings and cylinders. Some of these compressors have independent systems for the cylinders and bearings. In the former designs, the viscosity of the oil is fixed by the requirements of the cylinder and not those of the bearings. Viscosity requirements of the oil for the cylinders are generally somewhat higher than those of the bearings in order to provide adequate piston seal.

As shown in the table, a higher-viscosity oil should be used in drop-feed, ring, and splash systems than in circulation systems, because in the latter oil is supplied in excess and keeps the bearings cooler than with the other systems.

For reasons of simplicity and to minimize the danger of mixing, as few oils as possible should be used, especially on the same machine. Consequently, wherever possible, one oil should be used for lubricating both the cylinders and bearings.

Because of constant agitation and churning of the oil over long periods in the presence of air, conditions in circulating, ring and splash systems are conducive to oil oxidation. If oil of inferior quality is used in these systems, oxidized products combine with atmospheric impurities and water, if present, to form sludge. Sludge, if permitted to accumulate, is likely to restrict and in severe cases to stop the flow of oil through the pipes, and ducts leading to the bearings. Sludge also acts as a catalyst to promote oil oxidation and degradation in general. Moreover, it increases the persistence of any emulsion that may be formed. Every effort should, therefore, be made to keep the crankcase clean and the oil free of sludge.

Water enters the crankcases of compressors either from condensation of atmospheric moisture or through leakage of the cooling-water jackets. When a mixture of oil and water is churned, a heavy-mayonnaise-like emulsion is likely to form, especially if sludge and other impurities are present. Such emulsions tend to clog pump screens, oil pipes, ducts, grooves and to coat oil-cooler tubes. It is advisable, therefore, to use oils that have a high resistance to emulsification (low steam-emulsion number) so that water will have the least possible effect.

Most compressors are operated in comparatively warm surroundings, but some, particularly portable units, are often exposed to very low temperatures. In these cases, the oil should have a pour point at least as low as the surrounding air temperature. Otherwise, the oil will not flow freely to the pump suction when starting up, or through the orifices of drop-feed cups, or the wicks of wick-feed oilers. Congealed oil will also tend to channel in splash systems. In any of these cases, oil having too high a pour point will not be promptly nor adequately supplied to the bearings.

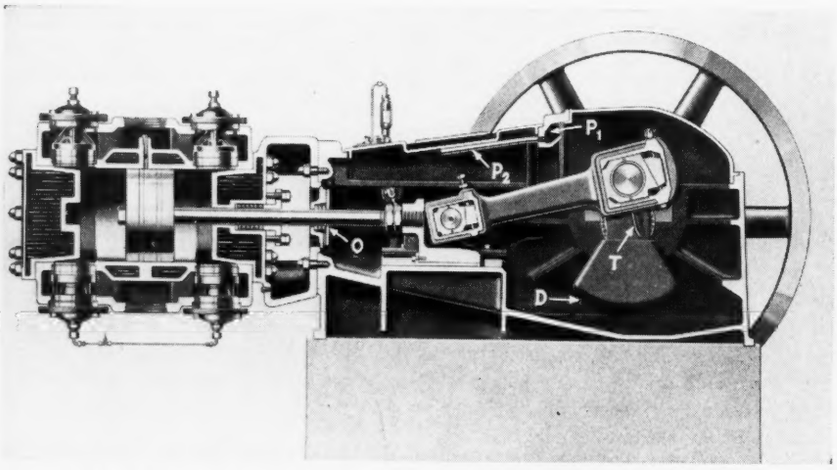


Fig. 4—Splash-lubricated horizontal compressor. Oil splashed into pocket P_1 runs through pipe P_2 to lubricate cross-head pin and guides

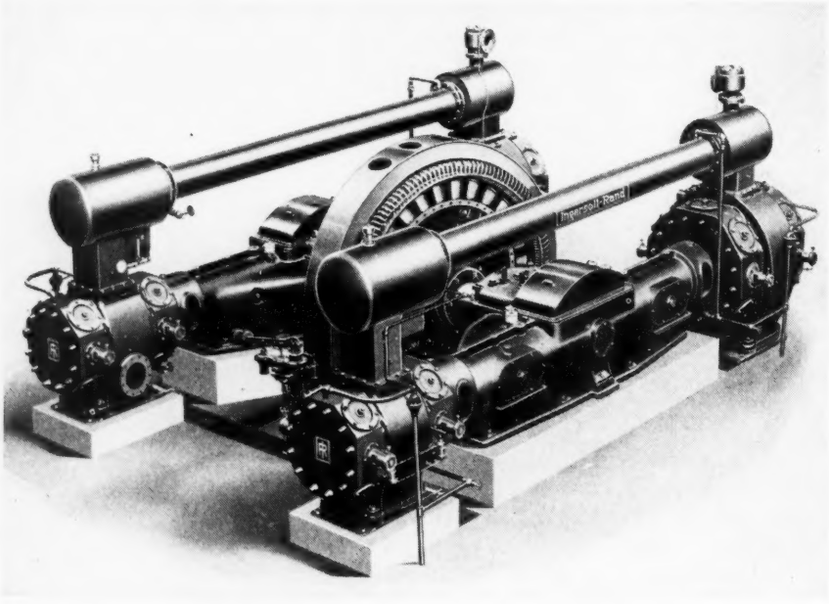


Fig. 5—A 4-cornered type compressor, which combines two duplex machines in a single unit, is force-circulation lubricated and driven by a 1000-hp motor

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Welding Repairs Scored Journals

WHEN SHAFT BEARING-JOURNALS BECOME SCORED, it is quite common practice to true the surface of the journal in a lathe and make a new bearing, or bore out and babbitt the old one to fit. These methods are objectionable because the journal is undersized, the oil rings may not work properly, and when new bearings are required they will have to be specially made.

A better method is to electric-weld a layer of metal to the journal, then turn it to the correct standard size and install a new standard bearing. Another method that has been used is to turn the journal under size and shrink a section of steel tubing onto it, after which the journal is turned to standard size.

Philadelphia, Pa. S O SMITH

Shavings Make Steam

Efficient utilization of wood waste and other plant improvements cut power costs at Pratt, Read & Co Inc, Ivoryton, Conn. W W Gaylord, consulting engineer, describes method of handling and burning waste and discusses operating experiences

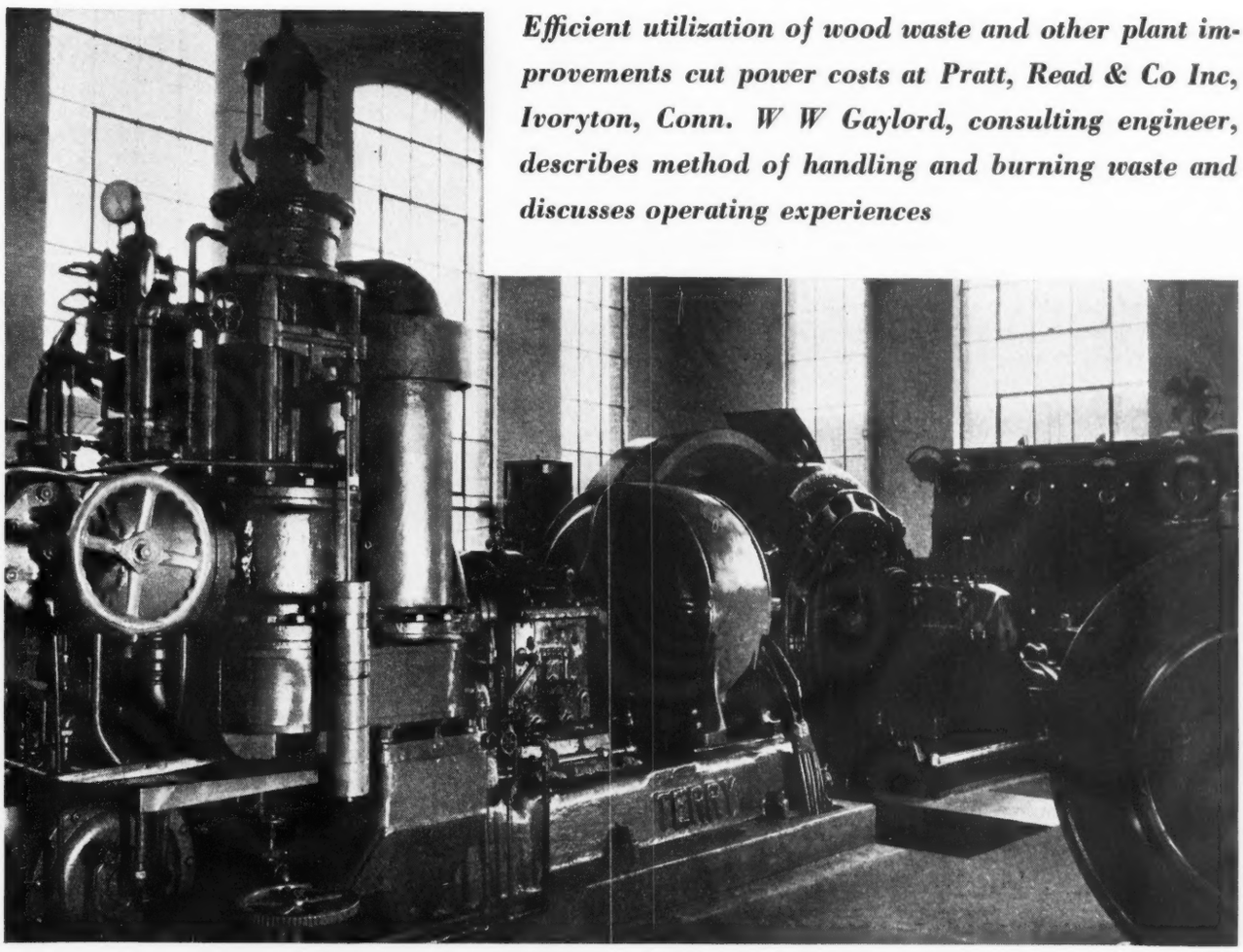


Fig. 1—Mixed-pressure turbine moved from another plant improves heat balance

▶ EFFICIENT BURNING OF WOOD WASTE is the heart of the power situation at Pratt, Read & Co Inc, Ivoryton, Conn, makers of piano keyboards and actions. Of the nearly two million board ft of raw lumber used, only about 40% appears as finished products. Studies show the woods used (pine and basswood for keyboards and maple for actions, all kiln-dried) have an average weight of 4 lb per board ft and that available heating value per lb averages half that of coal. Thus each million board ft of raw lumber represents 1200 tons of wood fuel, equivalent to 600 tons of coal.

Wood waste has been burned at this plant for many years, but the object had been the quick disposal of the waste rather than its efficient use as fuel. Old equipment consisted of four hand-fired 1500-sq-ft hrt boilers, burning wood in combination with coal. Sawdust and shavings from the plant collector system fed directly from the bottom of the collector to two of these boilers, through chutes entering the setting just under the shell at the boiler front. Coarse waste, such as trimmings from the saws, was thrown in by hand over the top of the coal fires in the other two boilers.

After a merger put this plant under control of the present management, a complete study of the plant was made which showed low efficiency in use of waste fuel and high labor cost because of hand firing. The plant generates all its own power at 125 volts dc, except for a small utility connection which supplies ac for fluorescent lighting and special high-frequency motors. The boilers also supplied, through a reducing valve, a large demand for low-pressure process steam for kiln-drying, building heating, etc. Two 220-kw generators were driven by uniflow engines exhausting to surface condensers; these units were 20 years old but in good condition.

Water for the forced-circulation hot-water heating system came originally from one of the surface condensers, used as a water heater. Experience showed that exhaust from one engine was about double that required for heating so a large amount of exhaust steam was wasted. For this reason, a separate water heater supplied with live steam had been installed and both engines were operated condensing.

As a result of the merger, a similar plant was abandoned, making available a 100-kw Terry mixed-pressure turbine-generator (Fig. 1). This was moved to Ivoryton and installed to per-

mit one engine to be run noncondensing, with the necessary amount of exhaust going to the water heater and the remainder going to the turbine.

The general plant study indicated that major savings could be made in the boiler room and it was there that the principal changes were made. The four 1500-sq-ft hrt boilers were nearly 40 years old and set low in one battery, making it inadvisable to modify them for more efficient combustion.

Calculations showed that the wood waste available, if efficiently burned, would supply about one-third of the total fuel requirements. It was evident that any basic improvements meant a hog to reduce wood trimmings to a size that could be handled through the collector system, a storage bin to equalize flow of wood fuel to the furnace, and some means of feeding wood to the furnace at a uniform rate without introducing excess air. Because of the wide range of steaming requirements it proved desirable to be able to vary the rate of feeding over a 3-to-1 range.

Analysis of the steam load, together with available records of steam use, indicated that a boiler to deliver 20,000 lb per hr continuously would be most economical. There was no space available for such a unit without removing some of the existing equipment. Dismantling one old boiler and making a few changes in the building made the needed space. There was room in an adjacent building for the wood hog and storage bin.

The boiler unit finally selected is a Riley RO boiler with a single-retort underfeed stoker, rated to produce 20,000 lb per hr continuously. The stoker is steam operated and a steam turbine drives the forced-draft fan. The unit followed standard design except that furnace height was increased to give a volume about 25% greater than would have been used for burning coal alone. The wood fuel enters through two chutes placed as high as possible in the front wall and pointed down at an angle of 45 deg. Fig. 3 shows the general arrangement.

Wood-Feeding Equipment

Equipment for feeding the wood to the furnace was designed especially for this job. The added equipment needed to provide a controlled feed to the furnace was installed in conjunction with the existing collector system. A Jeffrey hog, of 1-ton-per-hr capacity (Fig. 2), was installed in the basement of the building adjacent and connected to the boiler house. A high-speed exhauster fan takes the shredded wood from the bottom of the hog and deposits it in the main collector (Figs. 3, 4), where it mixes with sawdust and shavings from the main system. From the collector the wood falls to a 1000-cu-ft storage bin fitted with 9 screw conveyors to form a live bottom. Conveyors are driven in three groups of three each, and deliver the wood to a gathering conveyor which discharges it to the suction stream of a high-speed exhauster fan. The fan lifts the hogged wood to a small cyclone over the boiler from which it falls to the boiler furnace (Fig.5). In this way it is possible to introduce the wood fuel to the furnace with only a reasonable amount of excess air even at the lowest rate of wood feed. At maximum feed rate, air has to be supplied in the furnace.

More or less steady load conditions while the plant is in operation permit use of a simple method of furnace control. There is, of course, a big difference between day and night loads but this change occurs at known times so the operators can shut off or start up one or more sections of the wood feeder, as required. A Cash regulator controls operation of stoker and forced-draft fan from steam pressure at the superheater outlet. Operators set wood

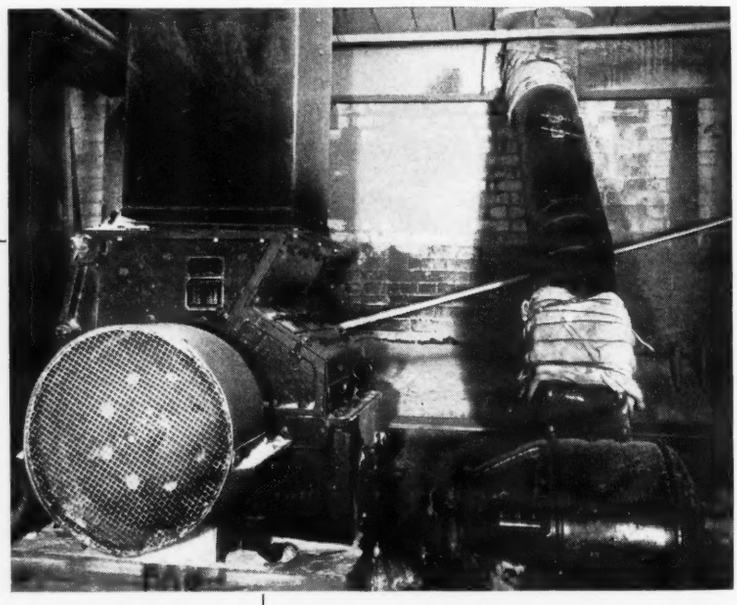


Fig. 2—"Hog" reduces wood waste to uniform small size; high-speed exhauster fan at right lifts hogged waste to main collector bin

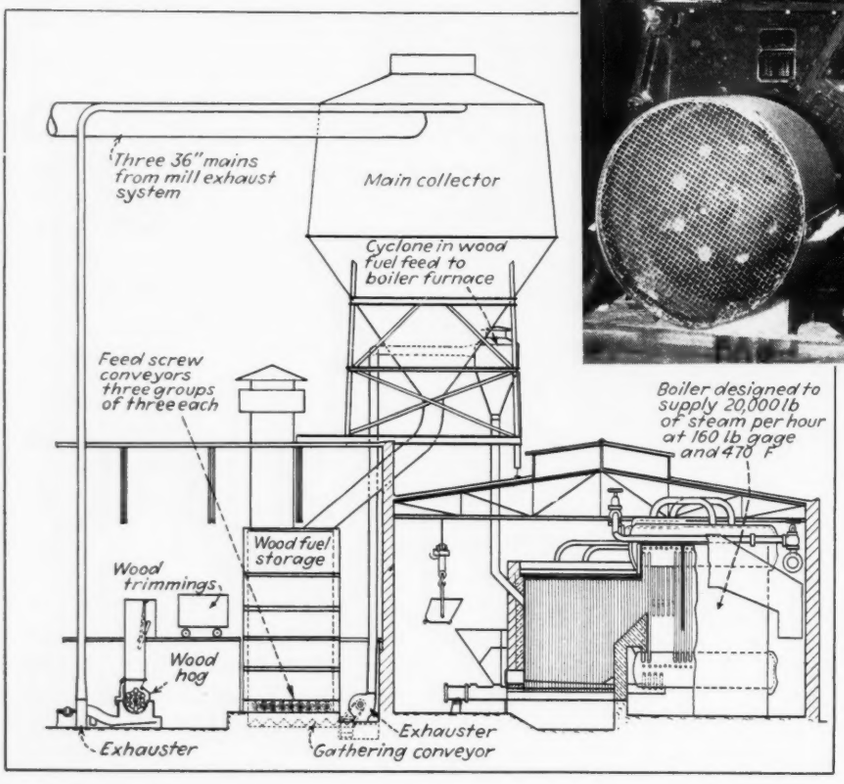

Three 36" mains from mill exhaust system
Main collector
Cyclone in wood fuel feed to boiler furnace
Feed screw conveyors three groups of three each
Boiler designed to supply 20,000 lb of steam per hour at 160 lb gage and 470 F
Wood fuel storage
Wood trimmings
Wood hog
Exhauster
Gathering conveyor
Exhauster

Fig. 3—Schematic diagram of fuel-handling system and boiler installation

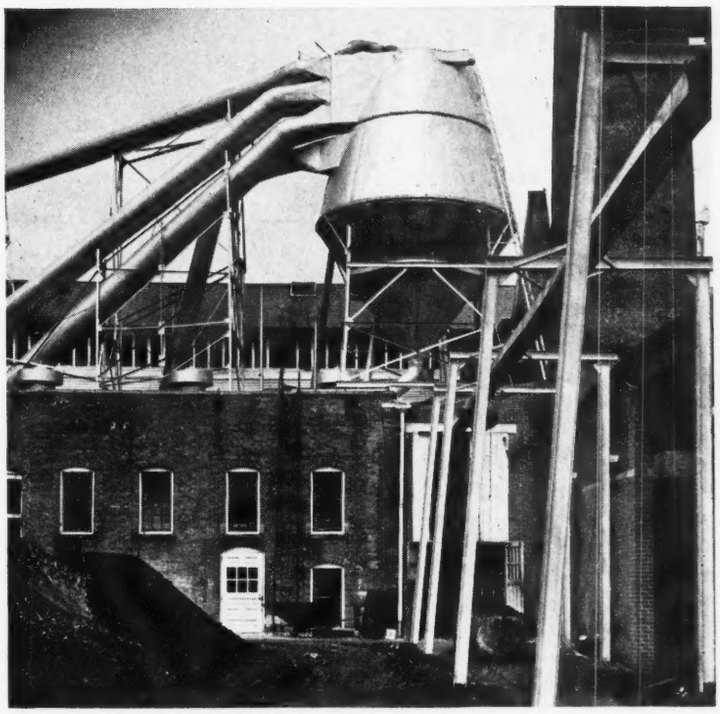


Fig. 4—Waste from various parts of plant goes to main collector on roof; new monorail improves coal handling from yard

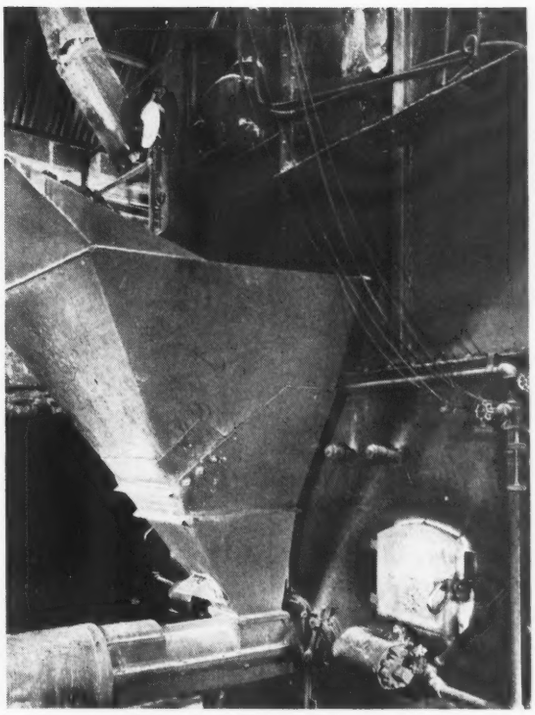


Fig. 5—Detachable chute, which supplies hogged fuel to furnace, is removed when burning coal alone

feed so that it supplies somewhat less than the total fuel requirements and the regulator takes full control.

With one group of screw conveyors running, the feeder was designed to deliver 63 cu ft of wood fuel per hr, or the equivalent of about 375 lb of coal. With three groups in operation, design delivery amounted to 188 cu ft, or the equivalent of 1125 lb of coal per hr. Experience has shown that actual deliveries run considerably less than this, varying with the ratio of shavings to hogged wood. Present method of operation involves running all three groups of screws during the day. Feed rate at night varies; the operators aim to have the storage bin empty, or nearly so when the plant machinery starts up in the morning.

Experience Record

Experience with this installation shows a number of things which could be changed to advantage in another installation. Designing wood-handling equipment to fit space available placed severe limitations on arrangements. Much of the trouble experienced in removing shredded wood from the hog could be eliminated if the wood could be fed down to the fan inlet instead of being lifted by the air stream. Considerable difficulty with clogging at the delivery end of the spiral conveyors indicates that it would be desirable to have the drive and reduction gearing on the opposite end so that the delivery end would be a little more accessible.

Before the boiler was installed, measurements of draft available at the base of the stack indicated that it was adequate to operate the boiler selected at full capacity. Experience shows that flue-gas temperature from the new boiler runs so much lower that available draft is insufficient to get maximum capacity from the plant. Operation of similar boilers in other plants points to the need for an induced-draft fan for high-capacity operation and steps are being taken to install one at this plant.

The chart (Fig. 6) shows coal consumption, steam output, and kwhr output for a 15-year period; dotted extensions of coal and steam lines indicate estimated use if no plant changes had been made, and shaded areas show estimated savings. Rapid load increase has led to consideration of a second boiler of similar design.

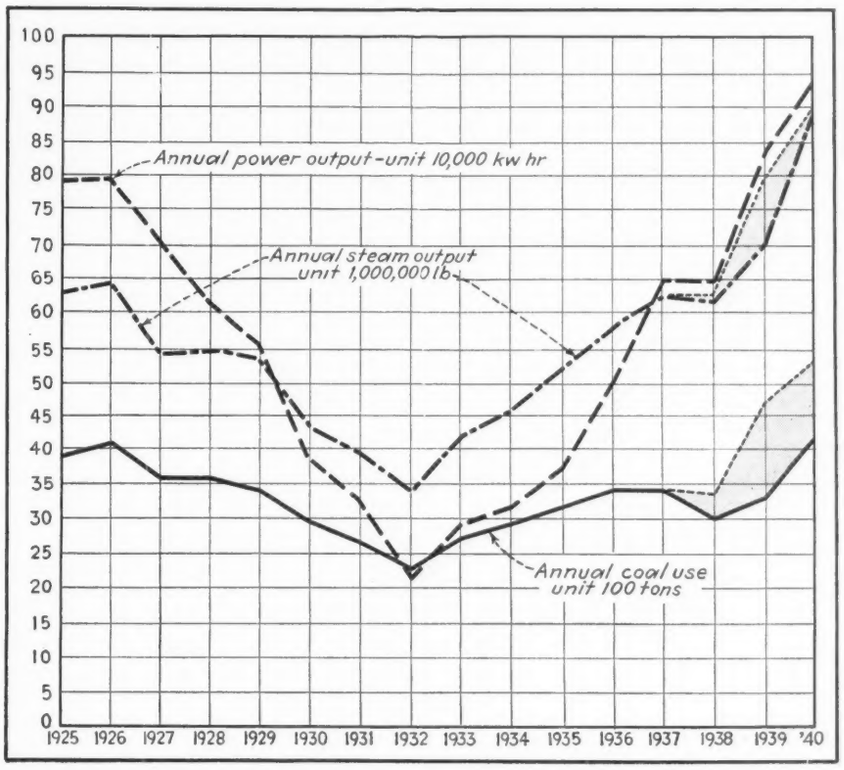


Fig. 6—Power trends at Pratt, Read & Co and savings from modernization

THE OLD CHIEF

Eighth in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks

VIII—What Men Say

"I wish someone would go up to my house and ask the old lady to loan them that big easy chair out of the parlor. If these fellows aren't going to work they might as well be comfortable"

▶ DURING THE MANY YEARS I was associated with the Old Chief, I noticed he had a habit of repeating certain little sayings, certain little jokes and using a certain mode of expressing himself, when faced with similar circumstances. Perhaps that is not an unusual trait in men who are getting along in years. My wife claims I always say the same thing when she asks me for an increase in her allowance, but I don't think this is a good example of what I mean.

If the Old Chief wanted a piece of pipe threaded, he would give the man the size and length and add, with a twinkle in his eye, "Put wrinkles on the ends". From the repeated use of the "wrinkle" joke, threading a pipe came to be known as "wrinkling".

You could be certain that when he noticed anything on the job out of plumb, he would tell the culprit that "Plumb is plumb and there is no plumb but plumb". Another repeater he invariably used when he discovered anything untidy, such as, say, a ragged untrimmed edge on a flange gasket, was to wind up his remarks on untidy work in general by saying, "Remember, neatness is the hall-mark of a workman".

Another saying we grew to expect when someone made a mistake in setting up some part of the process machinery was (this one was usually accompanied by pounding on something with a hammer), "If there are 99 ways of doing a thing right, and one way of doing it wrong, you fellows will do it wrong every time".

I think most old timers will agree with the statement that profanity and curses are now less in evidence in the workshops and power houses than they were in former days. In the old days the Boss had to be a "driver" to hold his job. If the work was not progressing satisfactorily, it was up to him to "vent his wrath" and lambaste the air to indicate that his displeasure was aroused by the ungodly slowness. In other words, in every shop there was a "Big Bull of the Woods" to take the place filled today by expert time-study men, intelligent and far-seeing production schedules, and, perhaps most of all, marked reduction in drudgery and back-breaking toil.

The right of a foreman to use his tongue as a lash to keep things moving was never questioned then as it would be today. Of the Old Chief it was often said that "his bark is worse than his bite". In his moments of ire his remarks were seldom addressed to anyone in particular, but were given out in a general manner, usually mixed with sarcasm. For instance, he came across some men loafing on the job and he remarked, loud enough for all to hear, "I wish someone would go up to my house and ask the old lady to loan them that big easy chair out of the parlor. If these fellows aren't going to work they might as well be comfortable."

There were exceptions when he would be both personal and flowery. He once referred to a clumsy watchman as "a fatuous foot-handed fathead". A white-faced stock-room clerk, who had bungled an order, was designated "a Lazerous-looking, half-baked Hoosier".

Then there was the unforgettable incident that happened shortly after we installed the then "new-fangled" dump grates. One unfortunate man dumped the ashes and forgot to clear his ashes or raise the plates again. In a few hours the well was a mass of clinker and hot ashes. The Old Chief's language did full justice to the occasion; the words "uncannonized" and "uncrimsoned" were mixed with many other adjectives of a genealogical nature to relieve his feelings.

There was one word that for those who knew him had only a dire and purposeful meaning, and that was the word "farmer." The Old Chief might call a man anything else under the sun and count him in his good graces within the hour, but if he once referred to a man as a "farmer," it meant that man was slated to be fired.

The score of names wasn't all on one side. The Old Chief was often called "Zybysco" (after a champion wrestler of the day), "Simon Legree", "Old Fuss Budget", but woe betide anyone outside the power house who dared to speak disrespectfully of our Old Chief.

OIL AND GAS POWER—1941

Here Are the Facts

"MY FACTORY'S POWER REQUIREMENTS are such and such. We buy power, but wonder if generating our own with a diesel wouldn't be cheaper? What would such a plant cost?" The words differ, the question comes from various parts of the country, the factory becomes a flour mill, a machine shop, a laundry, an ice plant—but this is the gist of scores of letters received every year.

Executives and power engineers everywhere face the problem of cutting power costs, tougher than ever today, and they want to know the facts. They want to know whether to make or buy power, and if "make" is the answer they want to know the best way.

Basically, this is a job for competent consulting engineers. They can marshal the facts and reach the conclusions needed to give the actual answer for a specific case. But executives and power engineers need facts and figures for preliminary thinking, for rough comparison, and for intelligent cooperation with the consultant.

This 8th annual oil and gas power special section presents the case for the internal-combustion engine. The following pages form what might be called a "report to executives"—a non-technical but nevertheless factual and accurate statement of the "hows and whys" of diesel and gas-engine power, including the all-important "how much?" A concise listing of types and sizes of engines available (page 84) and the annual listing of typical new installations (page 80) provide the remaining instruments needed for an intelligent diagnosis.

How Oil and Gas Engines Work

DIESEL AND GAS ENGINES, and the familiar automobile engine, have this in common—they convert raw fuel and air into power, and they do the job *inside* a cylinder. The mixture of fuel and air compressed in the cylinder burns, and the resulting expansion pushes on a piston which turns the engine shaft. Engines operating on this general principle are called *internal-combustion* engines.

In the familiar automobile engine and in the gas engine, fuel and air mix outside the cylinder and the piston compresses the *mixture* before ignition (Fig. 2). In the other three types shown, usually designed to handle oil fuel, the piston compresses *air only* and fuel sprays into the compressed air just before ignition occurs.

Some means of firing the fuel-air mixture must be provided, and this constitutes another difference between engines. In *spark-ignition* engines, a high-tension electric spark does the job. In *surface-ignition* engines, a bulb or plate in the combustion chamber is arranged without water cooling so that the combustion process will keep this small surface hot. The hot surface fires the compressed mixture.

Compression Ignition

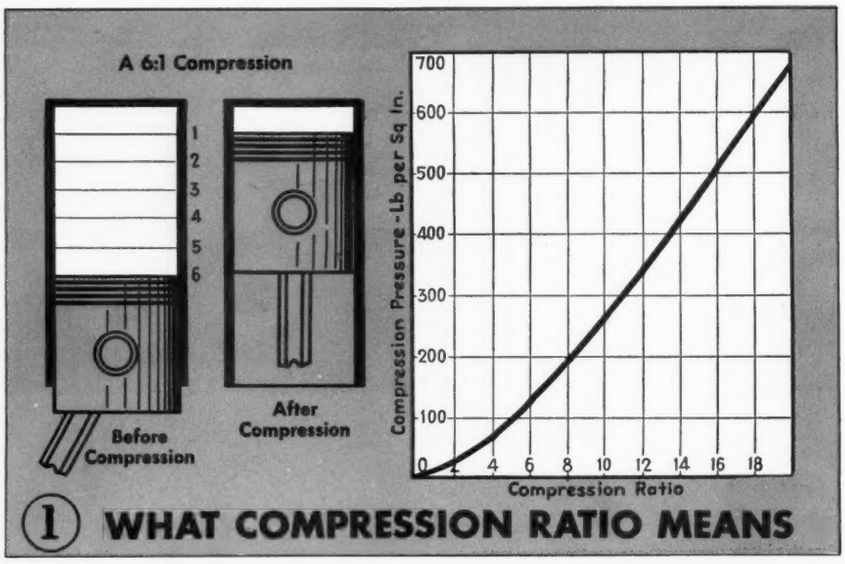
Diesel engines have no external means of ignition. Use is made of the fact that as air, or any other gas, is compressed, its temperature rises. Air at 500 lb pressure is "red hot"—its temperature runs about 1000 F. Oil sprayed into such superheated air will ignite and burn without other help. This is called *compression ignition.*

Compression ratio is the relation between the original volume and the volume at the end of compression. Fig. 1 shows this graphically and also shows compression pressures corresponding to various compression ratios. This relationship depends on cylinder size and design to a great extent; the figures given are representative.

Compression ratio is important for two major reasons: (1) the higher the compression ratio, the more efficient, in general, is the engine, and (2) the higher the compression ratio, the stronger and heavier the engine must be, and, other things being equal, the higher will be first cost.

Compression-Ratio Limit

In engines where fuel and air are compressed together, there is a limit to the compression ratio, depending on the nature of the fuel. Too much compression will cause the mixture to ignite before the compression is fin-



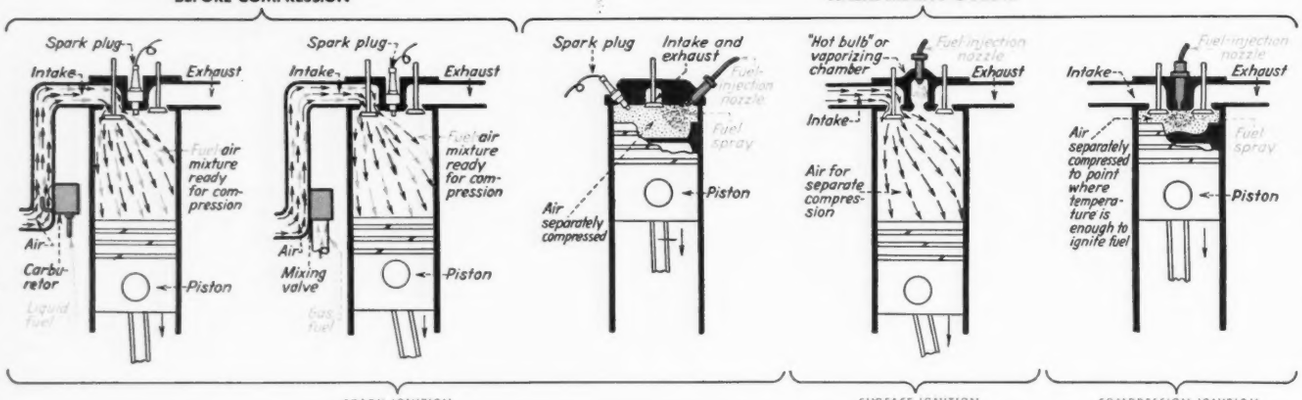
1 WHAT COMPRESSION RATIO MEANS

INTERNAL-COMBUSTION-ENGINE TYPES

2

FUEL AND AIR MIXED OUTSIDE CYLINDER, BEFORE COMPRESSION

AIR ONLY COMPRESSED IN CYLINDER; FUEL SPRAYED INTO CYLINDER WHERE MIXING OCCURS



SPARK IGNITION | SURFACE IGNITION | COMPRESSION IGNITION

GASOLINE ENGINE

1. Carburetor vaporizes fuel and mixes it with air in proper proportions.
2. Suction stroke, with intake valve open, fills cylinder with air-fuel mixture.
3. Compression stroke raises pressure of air-fuel mixture to 80-180 lb.
4. Spark ignites mixture near end of compression stroke.
5. The fired mixture expands, pushing piston down to produce "working" stroke.
6. Exhaust valve opens; rising piston clears cylinder of burned gas.

GAS ENGINE

1. Mixing valve blends air and fuel in proper proportions.
2. Suction stroke, with intake valve open, fills cylinder with air-fuel mixture.
3. Compression stroke raises mixture pressure to 70-300 lb, depending on fuel.
4. Spark ignites mixture near end of compression stroke.
5. The fired mixture expands, pushing piston down to produce "working" stroke.
6. Exhaust valve opens; rising piston clears cylinder of burned gas.

HESSELMAN ENGINE

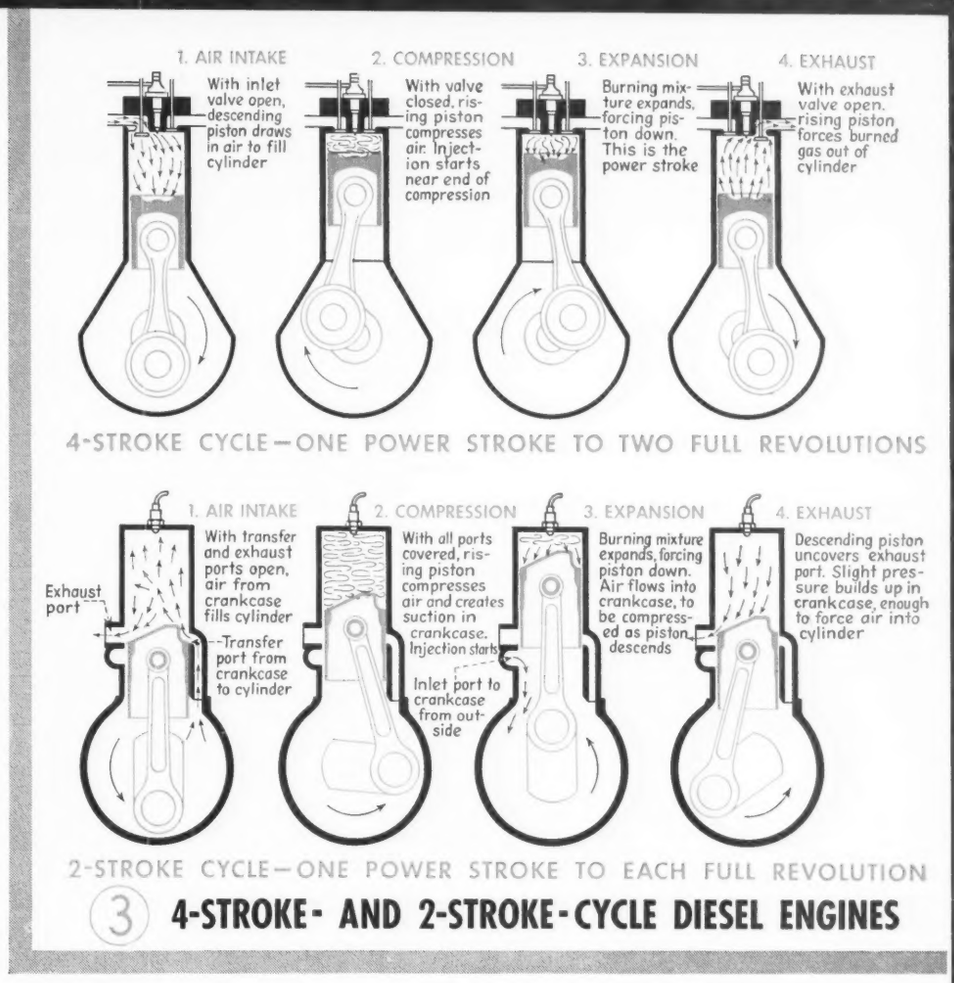
1. Suction stroke, with air-intake valve open, fills cylinder with air.
2. Compression stroke raises air pressure to 115-135 lb.
3. Fuel injection is completed before compression stroke ends.
4. Spark (just before compression ends) ignites fuel vaporized by compression and stored heat.
5. Combustion expansion pushes down piston, producing "working" stroke.
6. Exhaust valve opens; rising piston clears cylinder of burned gas.

VAPORIZING OIL ENGINE

1. Suction stroke, with air-intake valve open, fills cylinder with air.
2. Pump injects fuel to vaporizer; vapor formed mixes with burned gas and doesn't burn.
3. Compression stroke raises pressure to 60-150 lb; forces air into vaporizer.
4. Heated surface of vaporizer chamber ignites fuel-air mixture near end of compression.
5. Combustion occurs with explosive force, producing "working" stroke.
6. Exhaust valve opens; rising piston clears cylinder of burned gas.

DIESEL ENGINE

1. Suction stroke, with air-intake valve open, fills cylinder with air.
2. Compression stroke raises air pressure to 350-600 lb.
3. Fuel injection starts at or near the end of the compression stroke.
4. High air temperatures, caused by compression, ignite fuel.
5. Combustion expansion pushes down piston, producing "working" stroke.
6. Exhaust valve opens; rising piston clears cylinder of burned gas.


1. AIR INTAKE
With inlet valve open, descending piston draws in air to fill cylinder
2. COMPRESSION
With valve closed, rising piston compresses air. Injection starts near end of compression
3. EXPANSION
Burning mixture expands, forcing piston down. This is the power stroke
4. EXHAUST
With exhaust valve open, rising piston forces burned gas out of cylinder
4-STROKE CYCLE—ONE POWER STROKE TO TWO FULL REVOLUTIONS
1. AIR INTAKE
With transfer and exhaust ports open, air from crankcase fills cylinder
Exhaust port
Transfer port from crankcase to cylinder
2. COMPRESSION
With all ports covered, rising piston compresses air and creates suction in crankcase. Injection starts
Inlet port to crankcase from outside
3. EXPANSION
Burning mixture expands, forcing piston down. Air flows into crankcase, to be compressed as piston descends
4. EXHAUST
Descending piston uncovers exhaust port. Slight pressure builds up in crankcase, enough to force air into cylinder
2-STROKE CYCLE—ONE POWER STROKE TO EACH FULL REVOLUTION

3 **4-STROKE- AND 2-STROKE-CYCLE DIESEL ENGINES**

ished, due to temperature rise. This is known as "knocking." Fuels such as coke-oven gas can only be compressed to 80-100 lb, while propane can be compressed to 350 lb, in some cases.

Other considerations govern compression pressure in engines where air is compressed separately. In *compression-ignition*, or diesel engines, the pressure must be sufficient to produce a temperature high enough to ignite the fuel spray. The temperature resulting from a given compression pressure depends on speed, cylinder size and design. Typical compression pressures range from 450 to 600 lb. In engines with specially designed combustion chambers, this pressure may be as low as 350 lb per sq in. If a heating device for starting is provided, an electric coil for example, compression pressure can be brought down to 250 lb. After starting, such an engine will operate by self-ignition. The low explosion pressures resulting mean less strain on engine parts and frame and thus may permit lower cost.

Where ignition devices of one kind or another are provided, compression pressure can be much lower. Surface-ignition engines usually have compression pressures of 60 to 150 lb, with maximum pressure of about 250 lb. The Hesselman engine, featuring fuel injection and spark ignition, operates with compression pressures in the neighborhood of 125 lb, and maximum pressures of 400-450 lb.

Cycles

Some internal-combustion engines operate on the *4-stroke cycle*, others on the *2-stroke cycle*. This simply means that in the first case, four strokes, or two complete revolutions, are required for the full cycle of intake, compression, combustion, expansion, and exhaust. In the second case, the cycle is completed in two strokes, or one full revolution. In other words, the 2-stroke cycle engine fires twice as often as the 4-stroke.

For a given cylinder size, the 2-stroke engine develops considerably more power than the four, and the construction is usually simpler. On the other hand, if the engines turn over at the same speed, the fuel injection and burning, and the elimination of exhaust gas must be handled in half the time.

Fig. 3 shows the events of the 4-stroke and 2-stroke cycles diagrammatically. Note that to blow the exhaust gas out of the cylinder and to fill it with fresh air, air at low pressure is required. This is called *scavenging air*. In the diagram, this pressure is obtained by using the crankcase and underside of the piston as an air compressor. This is called *crankcase scavenging*.

Another somewhat similar arrangement, known as *power-piston scavenging*, involves a separate chamber connected to the space under the piston and separated from the crankcase in such a way that the downstroke of the piston compresses the air drawn into the chamber on the upstroke of the piston. Air for scavenging may be provided by a blower, either driven directly from the engine, *integral scavenging*, or by an independent source of power, *separate scavenging*.

Fig. 3 shows *a port-scavenging* engine; scavenging air enters the cylinder and exhaust gas leaves by ports alternately covered and exposed by the piston. In *valve-scavenging* engines, air enters through a valve or valves, usually in the cylinder head, and exhaust gas leaves through ports. This arrangement may be reversed; air may enter through ports and exhaust gas leave through a valve.

Supercharging, not be confused with scavenging, means supplying air to an engine at greater than atmospheric pressure; this higher pressure is retained in the cylinder at the start of compression, which differs from the situation when scavenging. Supercharging increases the power output of a given engine up to 50% in some cases.

Fig. 2 shows that for gas and gasoline engines, fuel and air are mixed before admission to the cylinder. Where the fuel is a gas, mixing with air is simple; a *mixing valve* adjusts the proportions. When the fuel is a liquid, such as gasoline, it must be turned into a vapor, before mixing with air, by a *carburetor*.

In engines which compress air separately, fuel is sprayed or injected into the cylinder, under pressure. The most common system is *mechanical injection*, also called *solid injection*. A pump puts the liquid fuel under a pressure sufficient to force it into the cylinder and to break it into a finely atomized spray. This pressure may range from 1000 to 20,000 lb, depending on the design of the system and on the nature of the fuel to be atomized.

Solid Injection

There are two general systems of solid injection: (1) in the *common-rail* system, a single pump supplies fuel to a header at substantially constant pressure. Mechanically operated valves control fuel feed to each cylinder, regulating the time of injection and the amount of fuel. (2) In *pump-injection* systems, a separate pump cylinder sup-

plies each engine cylinder and the pump action controls the time of injection and the fuel quantity. The pump may be connected to the fuel nozzle by high-pressure tubing, or may be built into the nozzle unit.

Some large engines, particularly suited for handling heavy oil, are equipped for *air-injection*. Air, from a multi-stage high-pressure compressor, carries fuel into the cylinder through a spray valve, and breaks the fuel into the necessary fine spray. A fuel pump feeds oil to the spray valve, controlling the quantity; the spray valve controls the timing and rate of injection.

Speed Control

Various methods are used to control the output and speed of internal-combustion engines. In 4-cycle gasoline and gas engines, the total amount of fuel and air is increased or decreased to change the output of the engine. The proportion of fuel to air must be held fairly constant; if it exceeds limits in either direction it will refuse to burn and the engine will "miss". This is called *throttle governing*. In 2-cycle gasoline and gas engines, a full charge must be supplied to the cylinder so that complete scavenging will occur; the engine's output is controlled by changing the fuel supply only. This limits speed or output regulation to the range of burnable air-fuel mixtures (8:1 to 18:1). For operation on natural gas, a ratio of from 10:1 to 12:1 is about right.

Hesselman Engine

In the Hesselman engine, the air-fuel mixture stays the same during load changes, but the total quantity of mixture is controlled. A butterfly valve in the air supply increases or decreases amount of air in accordance with load changes. Resulting changes in pressure in the air-supply line cause a corresponding change in the amount of fuel injected and thus keep the fuel-air mixture at the proper proportions.

Oil engines operating by compression-ignition require a constant volume of air for compression, so the necessary compression pressure and temperature will be reached. Output of the engine is controlled by regulating the quantity of fuel injected. Because the fuel only mixes with the air around it and because it is common practice to supply more air than is needed to burn the largest quantity of fuel, there is no practical limit on how lean the mixture may be. In practice, the fuel-air ratio runs about 20:1 at full load and about 40:1 at ¼ load.

This difference in air-fuel ratios explains the fact that diesels have better part-load efficiency than gas engines. In general, the higher the cylinder temperature, the faster heat is lost from the cylinder. This loss stays constant at part loads in a gas engine but tends to decrease at part loads in a diesel.

Gas and Gasoline Fuels

Gasoline engines, equipped with carburetors, are limited to fuels that will vaporize readily. Gas engines, when operated at the appropriate compression pressure, will handle any gas that has fuel value—from the "lean" blast-furnace gas (90 Btu per cu ft) to the rich butane (3200 Btu). Most engines burn natural gas, at approximately 1000 Btu per cu ft.

Fuel-injection engines are designed basically to burn fuel oils. In general, the low-compression engines and the high-speed diesel engines perform best on light and medium fuel oils. Large, slow-speed, heavy-duty diesels will handle heavy oils, including some of the types burned in industrial boiler furnaces and referred to as "Bunker C" oil. Air-injection engines are commonly used to handle the heaviest oils.

Because both oil and gas fuels are available in some areas, at competitive prices, there has been a recent trend to engines capable of burning a range of fuels with equal success. *Convertible* engines operate either as standard gas engines or as diesel engines burning fuel oil. To convert from gas to diesel operation, cylinder liners are changed to reduce cylinder diameter, pistons are changed to increase compression pressure, and spark plugs are replaced by injection nozzles. The Hesselman engine will handle a wide range of liquid fuels. Removal of the fuel-injection nozzle and substitution of a carburetor permits burning gasoline, butane, propane, natural gas, or producer gas.

A recently developed engine burns either gas or oil on the full diesel cycle. This is an air-injection unit, and when burning gas, the air compressor handles gas, raising it to about 1100 lb pressure before injection into the cylinder through the regular diesel injection nozzles. A small and constant amount of pilot oil is supplied to the cylinders while burning gas, to stabilize combustion. This design permits quick change from gas to oil and gives the higher diesel efficiency when burning gas.

Efficiencies

Only part of the total energy in the fuel comes out as useful power at the engine shaft. *Thermal efficiency* is the percentage of the total energy of the fuel that the engine converts to useful work. The diesel engine has the highest efficiency of any power plant with the exception of the mercury-vapor plant, the last word in modern central-station practice. Thermal efficiency of the diesel engine runs up to about 34-35%, while that of the gas engine is approximately 25%.

What happens to the remaining 65% and 75%, respectively? This energy is lost in various ways; Fig. 4 shows typical heat balances for diesel and gas engines, at full load. Part of the heat given up by the engine is carried away in the cooling water circulated in the water jackets around the cylinders to keep the metal temperatures at reasonable levels. Another major heat loss lies in the hot exhaust gas, which goes to atmosphere. Where there is a use for heat, part of these losses can be regained in *heat-recovery* apparatus, as described on page 78.

WHERE ENGINE HEAT GOES

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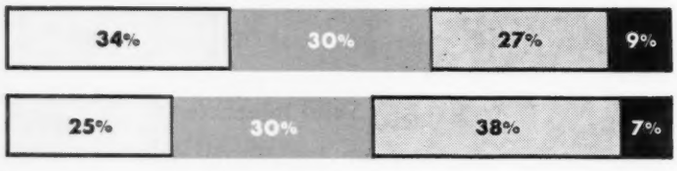
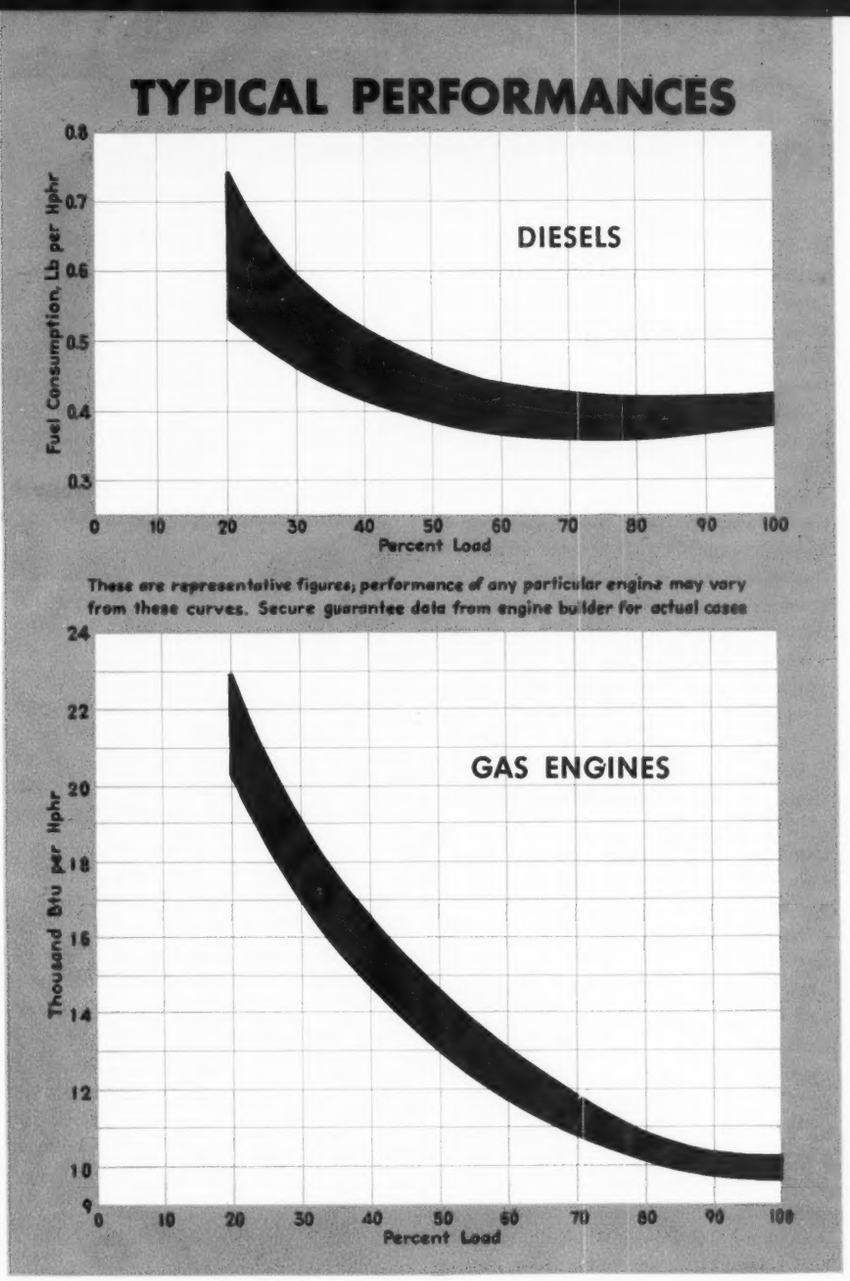


USEFUL WORK *Actual power output of engine. This figure, divided by total energy of fuel, equals the thermal efficiency.*

JACKET LOSS *Heat absorbed from pistons and cylinder walls by water in surrounding jackets.*

EXHAUST & RADIATION LOSS *Heat carried away in hot exhaust gas and heat radiated from engine and exhaust piping.*

FRICTION LOSS *Friction of crankshaft and connecting-rod bearings, pistons, etc. This goes to heat and adds to loss above.*



Engine Performance

■ THE PROSPECTIVE USER wants to know more about engine performance than thermal efficiency. Basically, he wants to know how much power-generating capacity a given engine has, and how much fuel will be required to produce a given amount of power. To understand and compare published engine ratings the user needs to know how they are determined.

Capacity is measured in brake horsepower, usually determined by test in the engine builder's shop. This represents *net* power delivered to the shaft coupling. In general, this figure includes power required to drive specific *engine auxiliaries,* such as circulating pumps for lube oil, etc. Power for general plant auxiliaries such as oil-transfer pumps, etc, is not included.

For a given size of cylinder, the output of an engine depends on the speed and on the *mean effective pressure* (roughly speaking, the average pressure on the piston during the power stroke). Both *speed* and *mep* have an important bearing on engine selection, particularly in relation to the nature of the load to be served. Continuous heavy loads usually mean selection of an engine with conservative speed and mep; higher speeds and pressures are used for lighter service.

The capacity of internal-combustion engines decreases at altitudes above sea level. The standard sea-level guarantee will hold good up to about 1500 ft, but at 5000 ft the engine must be de-rated about 16-18% and at 10,000 ft about 35%. These figures vary from engine to engine. Intake-air temperature also affects engine performance and if an engine is to be used where the intake temperature will exceed about 90 F, manufacturers should be asked to make guarantees on actual temperatures.

Fuel-consumption guarantees are expressed in units of fuel per net brake horsepower hour. For diesel engines, fuel-consumption is expressed in fractions of a lb of oil (19,350 Btu per lb); this is possible because diesel fuels have only a narrow range of heating values. Guarantees include a tolerance, usually about 5%, and within this tolerance, the engine builder absorbs small differences in conditions.

Oil engine guarantees are based on the *higher* heating value of the fuel. Fuels containing hydrogen have a *lower* heating value, as well. The difference between the two heating values depends on the amount of hydrogen present, ranging from 1-1.5% for fuel oil up to 7-10% for commercial gases. Because the difference is so much greater with gas fuels, gas-engine guarantees are based on the *lower* value. Likewise, because gas fuels differ widely in heating value, gas-engine guarantees are expressed in Btu per net brake hphr. To find the consumption of any particular gas, in cubic feet, divide the guarantee figure by the *lower* heating value of the gas, in Btu per cu ft.

Typical Performances

The curves (left) show typical performance of diesel and gas engines at full and partial loads. Although the curves go down to 20% load, it is not customary to guarantee fuel consumption at less than 50% load, because of difficulty in securing accurate results. In general, large engines show slightly better fuel consumption than small ones, and slow-speed engines run a little better than high-speed. The data on gas engines is for 4-cycle engines. Ordinary 2-cycle gas engines have full load fuel consumption rates higher than those shown above; injection of gas under pressure, a fairly recent development, brings 2-cycle gas-engine performance close to that shown for 4-cycle units. Spark-ignition oil engines approach diesel economy, showing fuel rates varying from 0.48 to 0.56 lb per bhp hr.

It should be noted that these figures represent what might be called "test" performance. Fuel consumption in actual operation will run slightly higher, depending on how well the unit is operated and maintained and on the general service conditions encountered. Actual average results from diesel plants are shown on page 79.

Accessory Equipment

AN INTERNAL-COMBUSTION ENGINE is practically a complete power plant in itself, but some accessory equipment is necessary. Accessories can be mounted on a single bedplate with the engine to form a completely self-contained unit; several manufacturers build standard units of this kind, up to about 100 kw capacity, and larger units can be obtained if desired.

Where space is available and portability is not required, it is common practice to mount major accessory equipment separately. In industrial plants, office buildings, institutions, hotels, etc, the engine room usually forms a part of the existing building. Municipal plants and central stations are usually housed in buildings erected for that purpose.

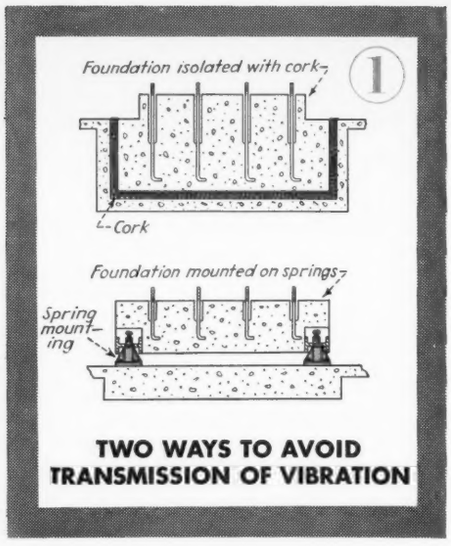
Buildings, Foundations

Because diesel and gas-engine plants are relatively compact and because the exhaust of properly operated engines is clear, they can be located almost anywhere. Proper installation usually eliminates possible nuisance from noise and vibration, permitting installation in basements of buildings, hotels, hospitals, etc.

While actual space requirements for diesel and gas-engine plants are small, a generous allotment of space will pay in ease of operation and maintenance. There must be enough headroom to permit pulling pistons and cylinder liners. Chain blocks will handle most hoisting in small plants, larger plants will probably require power hoists, and it may pay to install a traveling crane in plants of several thousand horsepower.

Small engines can be mounted on skids set on the floor, but for permanent installation of even small engines, a foundation of suitable design is recommended. Foundation materials are cheap and it pays to provide ample foundation size.

All reciprocating machinery vibrates to some extent. Normally, a well designed foundation will absorb most of the vibration and prevent its transmission to other parts of the building or to adjacent buildings. Where vibration transmission must be reduced to a minimum or where peculiar soil or building conditions create a special problem, the foundation can be isolated on cork or on spring mountings (Fig. 1).



TWO WAYS TO AVOID TRANSMISSION OF VIBRATION

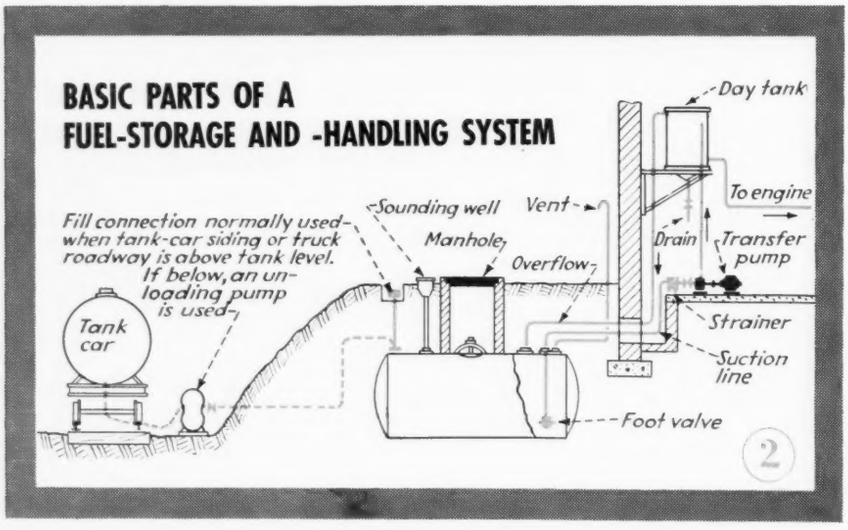
Fuel Handling

Fuel-oil storage and handling facilities vary with the size and nature of the plant and with its location. Plants in city buildings, where space is at a premium and where frequent oil deliveries are available, may find it economical to reduce storage capacity to a minimum but large storage may be the best answer for a municipal plant in a small and isolated town. In general, capacity should be at least slightly greater than the minimum shipping quantity (about 6,000–10,000 gal for tank cars, 200 gal for a tank-truck compartment). If space and cost limitations will permit, additional storage capacity means greater reliability, independence of shipping delays, and freedom in purchasing.

Whether tanks are to be underground or above, inside the building or not, depends entirely on local conditions. In any case, rules of the National Board of Fire Underwriters should be observed (NBFU Pamphlet 31—"Regulations for Installation of Oil-Burning Equipment"). The basic check on oil consumption is made by gaging tank level; facilities for gaging should be provided and the tank should be carefully calibrated. If possible, the storage should be divided between two tanks to permit cleaning or inspection without plant shutdown.

If the unloading point is above the tank, it may be filled by gravity; otherwise an *unloading pump* should be provided (Fig. 2). A *transfer pump* lifts fuel from the storage tank to the elevated *day tank* in the engine room from where it flows to the engine pump by gravity. Usually, one day tank is installed for each engine; size depends on engine fuel consumption, and on whether control of the transfer pump is automatic or manual.

A strainer or filter in the fuel-handling system, in addition to the filter usually furnished as regular engine equipment, is recommended. Normal diesel fuels require no further cleaning and no heating. Heavy fuel, with a high pour point, may require heating equipment in the storage and day tanks.



Lubrication

Each engine includes a built-in system for internal lubrication. The lubricating-oil system outside the engine exists primarily for removing contaminants which enter oil in use. Purifying may take one of four forms: (1) centrifuging, (2) filtering, by either absorbent or adsorbent filters, (3) chemical treatment, or (4) gravity settling. These systems are fully described in POWER, January, 1941, pages 70–73 and February, 1941, pages 60–62. Whether a simple filter mounted on the engine frame is used, or a more complicated treatment system, depends on the size of the plant and the conditions of operation. In general, treatment of lubricating oil pays in reduced consumption and in better operation.

Cooling

Constant and adequate circulation of water through the jackets is essential to successful operation; it is the job of the *cooling system* to provide this circulation. In the simplest arrangement (Fig. 3A), a pump takes raw water from a lake, river, well, or city-water supply and passes it through the engine jackets back to the source or to a sewer. An elevated tank may be added to provide an emergency supply or to decrease the running time of the pump. This system, called an *open circuit,* wastes water and so cannot be used economically where water is scarce or expensive.

Fig. 3B shows a *closed circuit;* the same water is constantly re-circulated. This means providing a device to remove heat from the water. Cooling towers, evaporative condensers, and spray ponds provide cooling by evaporation; they use about 5% of the water circulated. Radiators, in which an air stream removes the heat, require no makeup water except for leakage. Radiators and evaporative condensers find wide use in small plants; cooling towers and spray ponds are needed in larger plants. Both this and the preceding system have only *single circuits.*

A *double-circuit* system is shown in Fig. 3*C*. The water flowing through the engine jackets moves in a closed circuit, which, if kept tight, requires no makeup. If softened and purified water is used in this jacket circuit, it will remain that way and there will be no trouble with scale deposits in the jackets. Heat transfers from the *jacket water* to the *raw water* in a heat exchanger. Fig. 3*C* shows an open raw-water circuit, Fig. 3*D* a closed raw-water circuit. The arrangement of 3*B* is the same, in effect, as 3*D* when an evaporative condenser or a radiator is used, because in both cases little or no makeup is added to the jacket circuit.

Manufacturers recommend cooling-water temperatures for their own engines and these should be followed. It is important to note that in open systems and in closed single-circuit systems, where scale formation may be a problem, the maximum temperature should be less than 140 F and preferably around 100–120 F. For double-circuit installations, the usual temperature ranges from 140 to 160 F with the difference between water entering the jackets and leaving being held to about 10–20 F. Recent experiments with jacket-water temperatures as high as 240 F, on gas engines, are interesting from a heat-recovery angle (see POWER, March, 1940, page 79).

Air Filters, Mufflers

No special air-intake system is required for diesel and gas engines; air can be drawn into the engine directly from the surroundings. In most cases, however, where air is taken from the engine room, some form of manifold is provided. If the air is at all likely to prove dusty, an air filter will prove a good investment. If air is taken from outside, a pipe of ample size is run from the engine to a point outside the building and the inlet opening is protected by a hood and a screen. A filter is usually provided to insure clean air. Where noise reduction is important, an intake muffler may be installed.

The exhaust system discharges the products of combustion outside the engine room. Most systems include a muffler. Exact arrangement of piping depends on the local conditions; in office buildings, department stores, etc, existing stacks or vents may be used; in the case of separate buildings, the muffler is often outside the building.

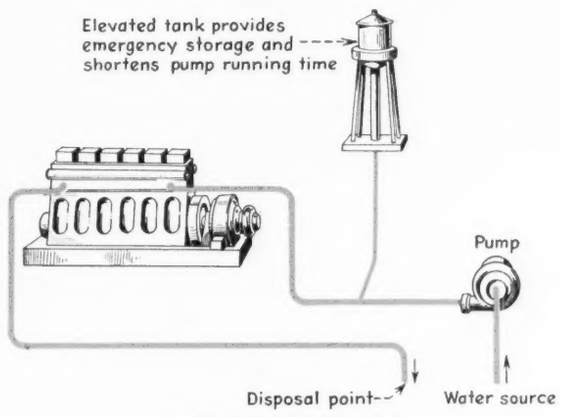
Heat Recovery

Heat in jacket water and in exhaust gas, constituting more than half of the total heat in the fuel, can be recovered in many ways, some of which are illustrated in Fig. 4. Because of its low temperature, jacket-water heat can only be used for making hot water. This may be used for service water, for building heating, for boiler feeding, or for process work. Water can be pumped through the jackets and directly to a storage tank or the place of use, but better results follow use of a double circuit like that shown in 4*A*. Because a constant flow must be maintained through the jackets, provision must be made to let excess hot water overflow, or some bypass arrangement must be used.

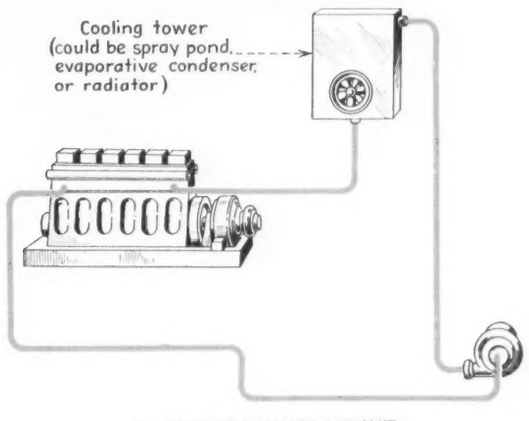
Where water temperatures above

3

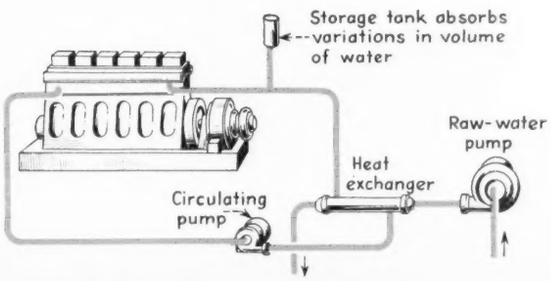
BASIC ENGINE-COOLING CIRCUITS



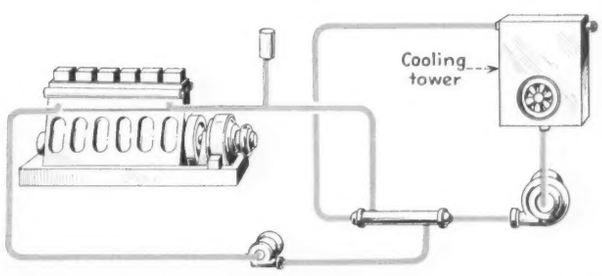
A–SINGLE OPEN CIRCUIT



B–SINGLE CLOSED CIRCUIT

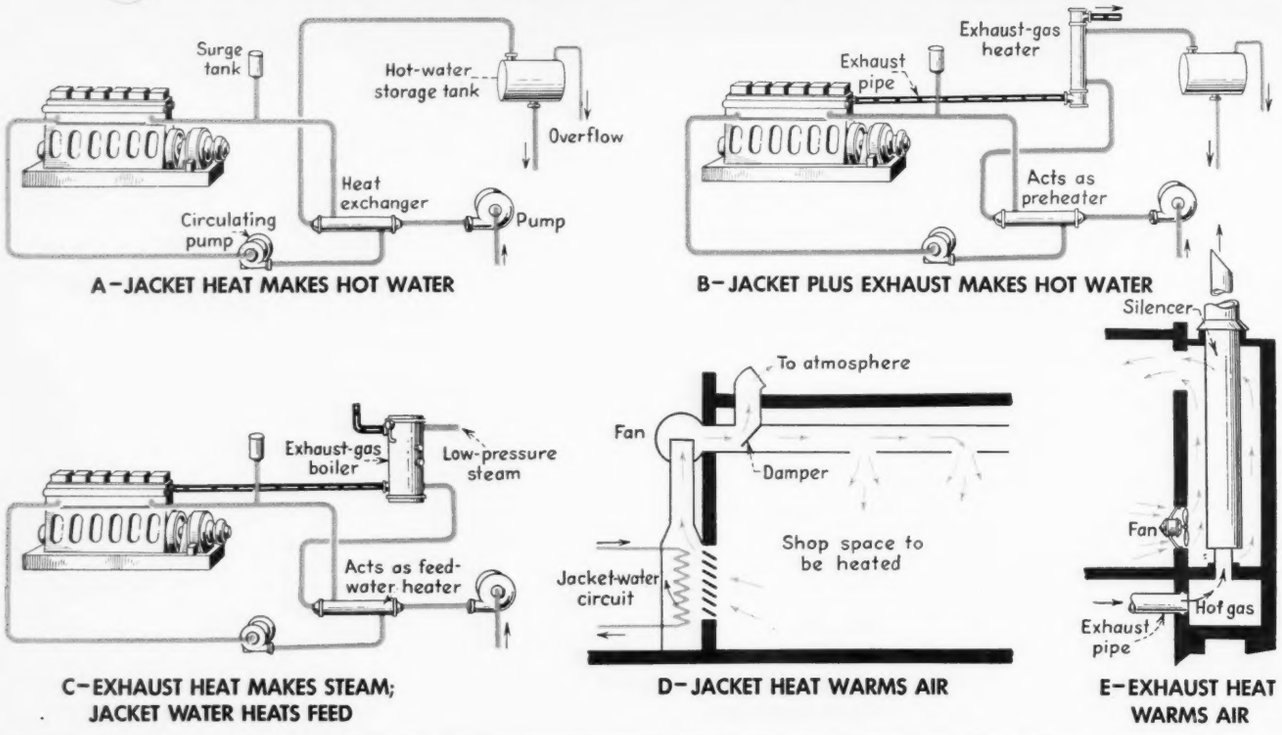


C–DOUBLE CIRCUIT, RAW-WATER SIDE OPEN



D–DOUBLE CIRCUIT, RAW-WATER SIDE CLOSED

④ TYPICAL METHODS OF HEAT RECOVERY



A–JACKET HEAT MAKES HOT WATER

B–JACKET PLUS EXHAUST MAKES HOT WATER

C–EXHAUST HEAT MAKES STEAM; JACKET WATER HEATS FEED

D–JACKET HEAT WARMS AIR

E–EXHAUST HEAT WARMS AIR

130–150 F are required, the exhaust gas may be used to raise the water temperature further. After preheating in a jacket-water heat exchanger, the water flows through an exhaust-gas heater, which may be a coil in the exhaust pipe, a water jacket on the exhaust manifold or pipe, or an exhaust-gas heater of standard design. If a simple *exhaust-gas* or *waste-heat* boiler is installed, low-pressure steam can be made. The high-temperature cooling system for gas engines, previously referred to, has as its main purpose increasing the yield of steam from a waste-heat hookup.

Figs. 4*D* and 4*E* show two ways to use waste-heat for warming a shop or factory building or the engine room itself. In the first case, jacket water circulates over a radiator built into a duct system. A fan draws air over the radiator, where it is warmed, and forces it through a duct system which distributes the warm air over the room. For temperature control and for summer operation when no heat is required, a damper which bypasses part or all of the warm air to an outside vent is provided. In the second case, the exhaust pipe and silencer are enclosed in a housing through which a fan circulates engine-room air. In winter months the warmed air returns to the engine room; in summer it passes out into the atmosphere.

Most jacket heat can be recovered in many cases. Exhaust heat recovered depends on the amount and temperature of the exhaust gas, which varies with engine design. To avoid corrosion, exhaust gas should not be cooled below 300 F. Articles in POWER, October, 1940, and March, 1941, give detailed information on heat recovery.

Starting Equipment

Starting an internal-combustion engine requires turning it over several times until ignition begins. There are five methods: (1) *hand starting*, which is limited to small gas engines and small diesels equipped with devices to relieve compression pressure, (2) *auxiliary-engine starting* in which a small gas or gasoline engine, hand-cranked, provides power to turn over a larger engine, (3) *motorized-generator starting* which is only practical where an independent source of electric current is available. (4) *battery starting*, in which electric storage batteries provide the power to turn the engine over, or (5) *compressed-air starting*, in which air under pressure is admitted to several cylinders, in proper sequence, to turn the engine over. The latter two methods find widest use, with battery starting common on small and medium size units, and air starting on larger units.

Gas engines require an ignition system, as do Hesselman oil engines. This may consist of a battery, distributor and spark coil, or a high-tension magneto. Most large engines and many small ones use the magneto system. On engines with a battery for starting, the battery ignition system will prove less expensive.

Governors, Controls, Drives

Internal-combustion engines include some form of governor as standard equipment. The prospective user should state the conditions of service clearly, so that the manufacturer can provide proper governing equipment. For variable-speed work, such as water pumping, engines can be equipped with controls to adjust speed to load conditions.

Automatic controls make operation easier and safe; with alarms to signal low-lubricating oil pressure, failure of cooling-water supply, etc, or with controls to shut down the engine under such conditions, the operator is freed to perform other duties.

While not absolutely necessary, operation is improved by indicating instruments to guide the operator. *Pyrometers* measure temperature of exhaust and so indicate combustion conditions, *thermometers* and *pressure gages* show conditions of oil and water circuits.

Internal-combustion engines may be used to drive equipment directly, in which case they are usually provided with a *flexible coupling* to correct minor misalignments, or with a *clutch* to permit engaging and disengaging load at will. Likewise engines may be connected to a load by *V-belt*, by *flat belt*, or by *chain drive*. Finally, and perhaps most common, engines drive *generators* for producing electric energy. In the latter case, voltage regulators, circuit-breakers, instruments, and the necessary panel boards must be provided.

How About Cost?

■ COMPARISON OF POWER COST from plant to plant is almost valueless because of differences in nature of load, cost of fuel and other supplies, and labor requirements. The soundest way to answer the cost question is to assemble careful estimates of each item in operating and fixed costs and to total them. The following paragraphs present the basic considerations.

Fuel—The chart below gives actual fuel consumption data for 115 diesel plants. Since both old and new plants are involved, performance of a modern plant would probably be better than average. A better method of estimating fuel consumption involves calculating the number of hours operation at various loads and multiplying by the guaranteed fuel consumption or typical data like those on page 75. The sum of these multiplications will be the total fuel requirement and cost can be figured from the average local price.

Lubricating Oil— Consumption of lube oil depends heavily on local plant conditions and on methods of operation and maintenance. Thus the only guide for estimating is a consideration of actual experience, as shown in the chart below. Taking account of the load on the proposed plant, the kind of lube-oil system planned, and the expected operation methods, a rough idea of lube-oil economy can be obtained. No similar data is available for gas engines, but the *Gas Engine Handbook* of the American Gas Association states that the average gas engine can be lubricated safely on the basis of at least 2000 hphrs of engine rating per gal of lube oil.

Maintenance—Amount of maintenance depends on engine design, nature of service, and methods of operation. In general, total maintenance costs will be less where systematic procedures are followed. Analysis of the Report on Oil-Engine Power Cost, from 1930 to 1939, indicates that a reserve of from 1 to 2 mills per net kwhr will cover maintenance and supplies for the average diesel plant. The *Gas Engine Handbook* suggests a reserve of 2 to 4% of the cost of a new engine, annually.

Labor— Actual cases show that one operator can handle up to 5000 hp, although this cannot be considered average. It is probably safe to figure on one operator for plants of less than 1000 hp; the total force will depend on the hours of operation, making due allowance for the 40-hr work week. In small plants the operator will have time available for other work. How much depends on the nature of the load, the convenience and accessibility of the plant and the amount of engine maintenance to be handled by the operator. Wages differ from place to place and also depend on responsibility involved.

Investment—Cost of a complete diesel plant, exclusive of buildings and foundations, varies with number of engines, kind of cooling system, and other features of design, but may be taken as ranging from $80 to $160 per kw. Large plants generally show the lowest unit cost. Addition of buildings, and building alterations, not required in all cases, and foundations, brings these figures to $100-$215 per kw.

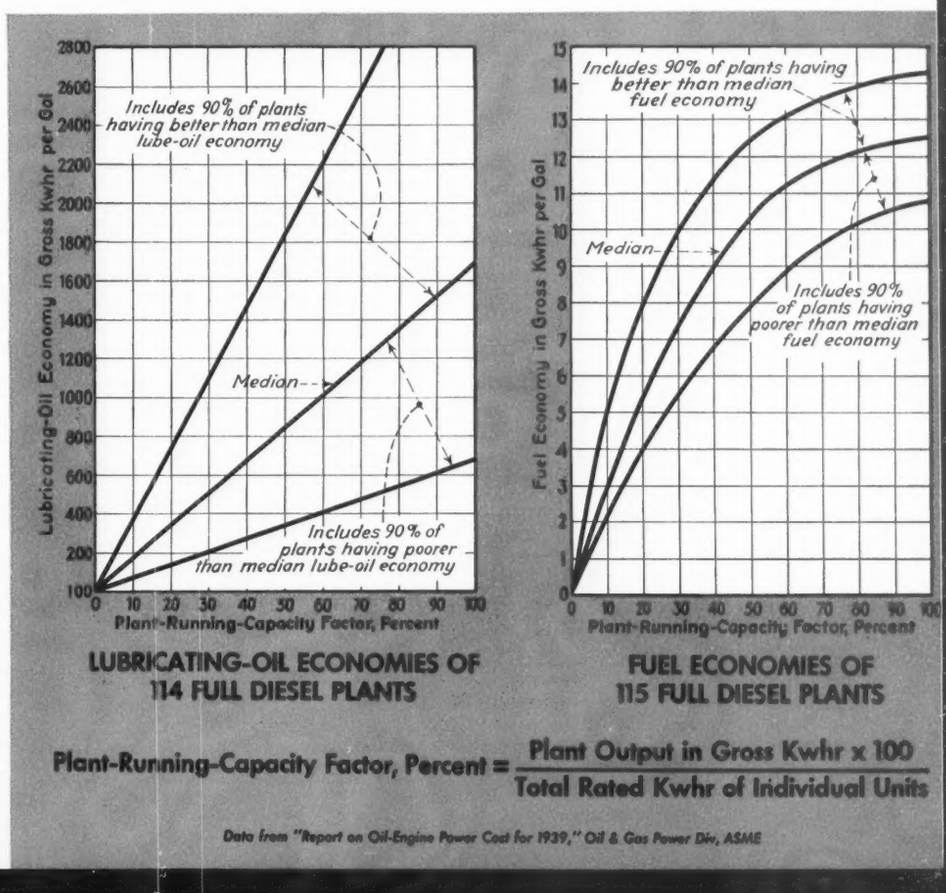
Cost of gas engines runs somewhat less than diesels of equivalent capacity, and usually no comparable fuel-storage and handling installation is required. Thus costs for gas-engine plants might reasonably be expected to fall somewhat below those given above.

Methods of economic analysis vary but a sensible procedure is to figure the difference in *operating cost* between alternative plans and then determine how many years will be required to pay for the difference in first cost. The decision rests on quickness of "payout."

Engine Life — Internal-combustion engines are designed with replaceable wearing parts so that their usefulness can be maintained almost indefinitely by adequate maintenance. Experience records show many engines with more than 25-30 years of service.

Reliability—An analysis of data on "enforced" shutdowns made for the period of 1929 through 1935 by M J Reed and brought up to date by Glenn C Boyer, covers 2642 engine years, totaling 8,839,109 hours of operation or an average of 3540 hours per engine per yr. The data shows 75 chances out of a 100 that no enforced shutdown will take place, 15 chances that there will be one or more shutdowns not exceeding 1% of the operating time, and only 10 chances that shutdown time will exceed 1% of operating time. The probability that enforced shutdowns will occur simultaneously on two units is very small and there is apparently no connection between engine age and shutdowns.

These books and pamphlets give valuable information to prospective users: "Standard Practices," Diesel Engine Mfrs Assn (Diesel Publications, 192 Lexington Ave, N. Y. C., $2.00); "Gas Engine Handbook" (American Gas Assoc, 420 Lexington Ave, N. Y. C., $1.00); "Oil Engine Power Cost Report" (American Society of Mechanical Engineers, 29 West 39th St, N. Y. C., $1.00 to members, $1.25 to others).


Lubricating-Oil Economy in Gross Kwhr per Gal
Includes 90% of plants having better than median lube-oil economy
Median
Includes 90% of plants having poorer than median lube-oil economy
Plant-Running-Capacity Factor, Percent
LUBRICATING-OIL ECONOMIES OF 114 FULL DIESEL PLANTS
Fuel Economy in Gross Kwhr per Gal
Includes 90% of plants having better than median fuel economy
Median
Includes 90% of plants having poorer than median fuel economy
Plant-Running-Capacity Factor, Percent
FUEL ECONOMIES OF 115 FULL DIESEL PLANTS
Plant-Running-Capacity Factor, Percent = Plant Output in Gross Kwhr x 100 / Total Rated Kwhr of Individual Units
Data from "Report on Oil-Engine Power Cost for 1939," Oil & Gas Power Div, ASME

Typical Diesel Installations

380 Engines Installed or Purchased Since April 1, 1940

Owner	Location	Equipt Driven	Engine builder	No. units	Hp each	Rpm	No. Cyl	Cyl bore	Cyl stroke	Cycle	Starting Method	Fuel injection	Fuel, lb per hp hr	Other capacity, hp, in same plant if known
Grand Haven	Michigan	CS Gen	Nord	1	3850	225	9	21½	31	2	A	A	....	D
U S Government	Hampton, Va.	Gen	Nord	4	3600	225	9	21½	29	2	A	S	....	.....
	Puerto Rico	Gen	Nord	1	2000	225	5	21½	29	2	A	S	....	.....
	Puerto Rico	Gen	Nord	1	2400	225	6	21½	29	2	A	S	....	.....
Rushville Power Co	Rushville, Ind.	CS Gen	BuS	4	3060	240	9	20½	27½	2	A	S	....	.....
Freeport	New York	CS Gen	BuS	1	3060	240	9	20½	27½	2	A	S	....	D
Light & Power Commission	Hutchinson, Minn	CS Gen	BuS	1	3060	240	9	20½	27½	2	A	S	....	D
Rockville Center	New York	CS Gen	Nord	1	3000	225	7	21½	31	2	A	S	....	D
Maquoketa	Iowa	CS Gen	BuS	1	2380	240	7	20½	27½	2	A	S	....	D
Georgetown	South Carolina	CS Gen	FM	1	1750	300	10	16	20	2	A	S	....	D
La Junta	Colorado	CS Gen	FM	1	1750	300	10	16	20	2	A	S	....	D
Iowa Public Service Co	Sioux City, Iowa	CS Gen	FM	1	1750	300	10	16	20	2	A	S	....	D
Marshall	Minnesota	CS Gen	FM	1	1750	300	10	16	20	2	A	S	....	D
Ia.-Neb. Light & Power Co	Shenandoah, Iowa	CS Gen	FM	1	1750	300	10	16	20	2	A	S	....	.....
Wisconsin Hydro Electric Co	Clear Lake, Wis.	CS Gen	BuS	1	1700	240	5	20½	27½	2	A	S	....	.....
Thief River Falls	Minnesota	CS Gen	BuS	1	1700	240	5	20½	27½	2	A	S	....	D
Borough of South River	South River, N. J.	CS Gen	FIW	1	1500	225	6	23	28	4	A	S	.38	2400-D
Marshall	Michigan	CS Gen	Nord	1	1500	257	6	17	25	2	A	A	....	D
Algona	Iowa	CS Gen	FIW	1	1500	225	6	23	28	4	A	S	.38	3525-D
Greenport	L. I., New York	CS Gen	FM	1	1400	300	8	16	20	2	A	S	....	D
Sikeston	Missouri	Gen	FM	1	1400	300	8	16	20	2	A	S	....	D
Northwestern Public Service Co	Yankton, S. D.	CS Gen	FM	1	1400	300	8	16	20	2	A	S	....	.....
Rochelle	Illinois	CS Gen	FM	1	1225	300	7	16	20	2	A	S	....	D
Lowell	Michigan	CS Gen	FM	1	1225	300	7	16	20	2	A	S	....	.....
Radford	Virginia	CS Gen	ALC	1	1170	257	8	17½	25	4	A	S	.375	2260-D
Kissimmee	Florida	CS Gen	ALC	1	1090	240	8	17½	25	4	A	S	.37	1215-D
Kosciusko	Mississippi	CS Gen	FM	1	1050	300	6	16	20	2	A	S	....	.....
Pitcairn	Pennsylvania	CS Gen	FM	1	1050	300	6	16	20	2	A	S	....	.....
Hearne	Texas	CS Gen	FM	1	1050	300	6	16	20	2	A	S	....	.....
Michigan Public Service Co	Boyne City, Mich.	CS Gen	FM	2	1050	300	6	16	20	2	A	S	....	.....
Hennepin Co. Coop-REA	Maple Lake, Minn.	CS Gen	FM	3	1050	300	6	16	20	2	A	S	....	.....
Le Sueur	Minnesota	CS Gen	FIW	1	1000	257	7	17½	24½	4	A	S	.37	750-D
Tri-County Electric Corp	Vestaburg, Mich.	Gen	Wor	1	1000	327	8	16	20	4	A	S	.39	.....
Natchitoches	Louisiana	CS Gen	ALC	1	1000	225	8	17½	25	4	A	S	.381	1560-D
Wisconsin Power Corp	Chippewa Falls, Wis.	CS Gen	Wor	1	1000	327	8	16	20	4	A	S	.39	D
Sterling	Kansas	CS Gen	BuS	1	1000	257	8	16½	24½	4	A	S	....	.....
Osceola	Arkansas	CS Gen	Wor	1	1000	327	8	16	20	4	A	S	.39	D
Hooven & Allison Co	Xenia, Ohio	Gen	Wor	1	1000	327	8	16	20	4	A	S	.39	.....
				1	625	327	5	16	20	4	A	S	.39	.....
Vinton	Iowa	CS Gen	BuS	1	1000	257	8	16½	24½	4	A	S	....	D
Nordberg Mfg Co	Milwaukee, Wis.	Gen	Nord	2	1000	257	4	17	25	2	A	S	....	.....
Toledo	Ohio	CS Gen	Sup	2	900	360	8	14½	20	4	A	S	....	.....
Columbus	Wisconsin	CS Gen	Wor	3	875	327	7	16	20	4	A	S	.39	.....
Garland	Texas	CS Gen	FM	1	875	300	5	16	20	2	A	S	....	.....
Fairfax	Minnesota	CS Gen	FM	1	875	300	5	16	20	2	A	S	....	D
Paulding	Ohio	CS Gen	FM	1	840	300	7	14	17	2	A	S	....	.....
U S War Department	Fort Huachuca, Ariz.	Gen	Ent	1	750	327	6	16	20	4	A	S	.39	.....
Pawnee	Oklahoma	CS Gen	FIW	1	750	225	6	17½	24½	4	A	S	.37	1400-D
Kenyon	Minnesota	CS Gen	Wor	1	750	327	6	16	20	4	A	S	.39	D
Black River Falls	Wisconsin	CS Gen	Wor	1	750	327	6	16	20	4	A	S	.39	.....
				1	500	327	4	16	20	4	A	S	.39	.....
Culpepper	Virginia	CS Gen	Wor	1	750	327	6	16	20	4	A	S	.39	D
Camden Forge Co	Camden, N. J.	Gen	Wor	3	750	327	6	16	20	4	A	S	.39	.....
Stanolind Pipe Line Co	Elmont, Kan.	Pump	ALC	1	730	257	5	17½	25	4	A	S	.375	.....
Homer	Louisiana	CS Gen	ALC	1	730	257	8	17½	25	4	A	S	.375	1000-D
Beloit	Kansas	CS Gen	ALC	1	720	600	8	12½	13	4	A	S	.385	1875-D
Scoville Mfg Co	Brooklyn, N. Y.	Gen	FM	1	700	300	4	16	20	2	A	S	....	.....
Greenville Oil Mill	Greenville, Miss.	Gen	FM	1	700	300	4	16	20	2	A	S	....	.....
Ash Grove Lime & Port Cem Co	Galloway, Mo.	Gen	FM	1	700	300	4	16	20	2	A	S	....	.....
Holyoke	Colorado	CS Gen	FM	1	700	300	4	16	20	2	A	S	....	D
Arcadia	Wisconsin	CS Gen	FM	1	690	300	6	14	17	2	A	S	....	.....
Madelia	Minnesota	CS Gen	FM	1	690	300	6	14	17	2	A	S	....	D
Dolite Co	Toledo, Ohio	Gen	Sup	1	625	400	8	12½	16½	4	A	S	....	.....
Kingman	Kansas	CS Gen	BuS	1	600	300	8	13	20	4	A	S	....	.....
W Michigan Electric Co-op	Scottville, Mich.	CS Gen	Wor	3	595	360	7	13¼	17½	4	A	S	.40	.....
South Eastern Pipeline Co	Atlanta, Ga.	Pumps	Wor	2	583	360	7	13¼	17½	4	A	S	.40	.....
Caldwell	Ohio	CS Gen	FM	1	575	300	5	14	17	2	A	S	....	.....
Serota Ice Co	Brooklyn, N. Y.	Gen-Comp	ALC	1	540	600	6	12½	13	4	A	S	.385	.....
Skaneateles	New York	CS Gen	ALC	1	540	600	6	12½	13	4	A	S	.385	.....
Livengood Placers, Inc	Livengood, Alaska	Dredge	Ent	1	525	400	8	12	15	4	A	S	.39	.....
Huntington	Indiana	CS Gen	Wor	1	510	360	6	13¼	17½	4	A	S	.40	.....
Carrollton	Missouri	CS Gen	Wor	3	510	360	6	13¼	17½	4	A	S	.40	.....
Carlton County Co-op	Kettle River, Minn.	CS Gen	Wor	3	500	360	6	13¼	17½	4	A	S	.40	.....
Bourne Mills	Fall River, Mass.	Gen	FM	2	500	400	5	12	15	2	A	S	....	.....
Steen Engineering Co	Dagsboro, Del.	Pump	Buc	1	490	600	8	10½	12	4	A	S	.40	.....
Geneseo	Illinois	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	D
Williamsport	Indiana	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
Surprise Valley Electric Corp	Alturas, Calif.	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
J S Packard Co	Boston, Mass.	Gen	Sup	1	450	...	6	12	15	4	A	S	....	.....
Western Pipe & Steel	San Francisco, Calif.	Gen	Atlas	8	450	350	6	13	16	4	A	S	.40	.....
Glidden	Iowa	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	D
Plain City	Ohio	CS Gen	Buc	2	450	360	6	13½	15½	4	A	S	.40	.....
Lake Crystal	Minnesota	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
Pennsylvania Shipyards	Beaumont, Texas	Gen	Ent	4	450	450	6	12	15	4	A	S	.39	.....
Grafton	North Dakota	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
Deschler	Nebraska	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	D
Warren	Indiana	CS Gen	Buc	1	450	360	6	13½	15½	4	A	S	.40	.....
Seymour	Texas	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
West Bend	Iowa	CS Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
Miami Mills, Inc	Miami, Fla.	Gen	FM	1	450	300	6	14	17	2	A	S	....	.....
Milan	Missouri	CS Gen	Wor	1	415	360	5	13¼	17½	4	A	S	.40	.....
Louisiana Materials Co	New Orleans, La.	Pump	Atlas	1	400	327	6	13	16	4	A	S	.40	.....
Pan Amer Petro & Trans Co	Houston, Texas	Pump	Atlas	8	400	327	6	13	16	4	A	S	.40	.....
Atlantic Pipe Line Co	Odessa, Texas	Pump	ALC	1	400	450	6	12½	13	4	A	S	.385	.....
Imperial Pipe Line	Cygnet, Ohio	Pump	RJ	1	400	300	5	13¼	22	4	A	S	....	D
Imperial Pipe Line	Wayne, Mich.	Pump	RJ	1	400	300	5	13¼	22	4	A	S	....	D
	Utica, Mich.	Pump	RJ	1	400	300	5	13¼	22	4	A	S	....	D
	Sylvania, Ohio	Pump	RJ	1	400	300	5	13¼	22	4	A	S	....	D
Brooklyn Brick Co	Brooklyn, Ind.	Gen	Buc	1	385	514	8	10	12	4	A	S	.40	D
Indiana Oxygen Co	Indianapolis, Ind.	Gen	Buc	1	385	514	8	10	12	4	A	S	.40	.....
				1	290	514	5	10	12	4	A	S	.40	.....

ABBREVIATIONS—ALC—American Locomotive Co, Atlas—Atlas-Imperial, Buc—Buckeye, BuS—Busch-Sulzer, Ent—Enterprise, FIW—Fulton Iron Works, FM—Fairbanks Morse, Nord—Nordberg, RJ—Rathbun-Jones, Sup—Superior (National Supply Co), Wau—Waukesha, Wor—Worthington.

Comp—Compressor, CS—Central Station, Gen—Generator.

Under other capacity, D is diesel, S is steam, G is gas engine. Under fuel injection, A is air, S is solid. Under starting method, A is air, E is electric, G is gasoline.

Owner	Location	Equipt Driven	Engine builder	No. units	Hp each	Rpm	No. Cyl	Cyl bore	Cyl stroke	Cycle	Starting Method	Fuel injection	Fuel, lb per hp hr	Other capacity, hp, in same plant if known
Indiana Bell Telephone Co	Indianapolis, Ind	Gen	Sup	1	350	600	8	9	12	4	A	S	....	
National Bulk Carriers	New York, N. Y.	Pump	Sup	2	350	600	8	9	12	4	A	S	....	
Parker Drilling Co	Port Arthur, Texas	Drill	Sup	1	350	600	8	9	12	4	A	S	....	
	New Iberia, La.	Drill	Sup	1	350	600	8	9	12	4	A	S	....	
Casco Bay Light & Water	Portland, Me.	Gen	Wor	1	340	450	6	10¾	14½	4	A	S	.40	
New York Telephone Co	New York, N. Y.	Gen	Sup	3	320	...	8	8½	10½	4	A	S	....	
				3	240	...	6	8½	10½	4	A	S	....	
New York Telephone Co	Albany, N. Y.	Gen	Sup	1	240	...	6	8½	10½	4	A	S	....	
Woodbine	Iowa	CS Gen	FM	1	300	300	4	14	17	2	A	S	....	
				2	225	300	3	14	17	2	A	S	....	
Commerce	Texas	CS Gen	FM	1	300	300	4	14	17	2	A	S	....	
Board of Water Commissioners	New Britain, Conn.	Gen	FM	1	300	300	4	14	17	2	A	S	....	
				1	225	300	3	14	17	2	A	S	....	
American Asphalt Paint Co	Chicago, Ill.	Gen	FM	1	300	300	4	14	17	2	A	S	....	
Brookston	Indiana	CS Gen	Buc	1	300	450	7	10	12	4	A	S	.40	
Premium Ice Co	New York, N. Y.	Comp	Atlas	1	300	327	6	11½	15	4	A	S	.41	
Conn. Lt & Power Co	Fisher's I, Conn.	CS Gen	Nord	2	300	400	6	10½	15	4	A	S	....	
Northern Lt & Power Co	Nome, Alaska	CS Gen	FM	1	300	300	4	14	17	2	A	S	....	
Thomasville Ice & Mfg Co	Thomasville, Ga.	Gen	Sup	2	300	514	8	9	12	4	A	S	....	
Manhasset-Lakeville Water Dist	Great Neck, N. Y.	Pump	Atlas	1	300	327	6	11½	15	4	A	S	.41	
Pemberton	New Jersey	CS Gen	FM	1	300	300	4	14	17	2	A	S	....	
Murray Furniture Co	Grand Rapids, Mich.	Gen	Buc	1	290	514	6	10	12	4	A	S	.40	
Edgar S Kiefer Tanning	Grand Rapids, Mich.	Gen	Buc	1	290	514	6	10	12	4	A	S	.40	
Bethlehem Steel Co	Jonestown, Pa.	Pump	Wor	1	280	450	5	10¾	14½	4	A	S	.40	
Lubec Water & Electric Dept	Lubec, Maine	CS Gen	Wor	1	280	450	5	10¾	14½	4	A	S	.40	
U S Engineers	Wendover, Utah	Gen	Wor	2	280	450	5	10¾	14½	4	A	S	.40	
U S Engineers	California	Gen	Wor	2	280	400	5	10¾	14½	4	A	S	.40	
Alaska Pacific Cons Mg Co	Wasilla, Alaska	Gen	Atlas	1	275	514	8	9	10½	4	A	S	.43	
				1	80	650	4	7	8½	4	A	S	.43	
Atkinson Dredging Co	Norfolk, Va.	Pump	Atlas	1	275	514	8	9	10½	4	A	S	.43	
Alabama Dryd. & Shipbuilding	Mobile, Alabama	Gen	Atlas	2	275	514	8	9	10½	4	A	S	.43	
Tampa Shipbuilding Co	Tampa, Fla.	Gen	Atlas	1	275	514	8	9	10½	4	A	S	.43	
National Bulk Carriers	New York, N. Y.	Gen	Atlas	4	275	514	8	9	10½	4	A	S	.43	
				2	200	514	6	9	10½	4	A	S	.43	
Scullin Steel Co	St Louis, Mo.	Comp	Atlas	1	275	514	8	9	10½	4	A	S	.43	
Ohio Bell Telephone Co	Toledo, Ohio	Gen	Sup	1	260	600	6	9	12	4	A	S	....	
Diesel Electric Co	New York, N. Y.	Gen	Sup	2	260	600	6	9	12	4	A	S	....	
Johnson W Ellis	Howellsville, Pa.	Gen	Sup	1	260	600	6	9	12	4	A	S	....	
Lester F Alexander Co	New Orleans, La.	Pump	Buc	1	257	550	5	10	12	4	A	S	.40	
Natchez	Mississippi	CS Gen	Buc	3	252	450	6	10	12	4	A	S	.40	
Parker Drilling Co	Bay City, Mich.	Drill	Sup	2	250	...	6	8	9½	4	A	S	....	
Adrian	Minnesota	CS Gen	Wor	1	250	450	5	10¾	14½	4	A	S	.40	
Geo B Barham	Odessa, Texas	Drill	Sup	2	250	...	6	8½	10½	4	A	S	....	
Carlin	Nevada	CS Gen	Wor	1	250	400	5	10¾	14½	4	A	S	.40	
Suckow Milling Co	Franklin, Ind.	Shaft	Buc	1	240	514	5	10	12	4	A	S	.40	
Cascade Rubber, Inc	Cuyahoga Falls, Ohio	Gen, Mill	Buc	1	240	514	5	10	12	4	A	S	.40	
Kahlbaum Bros	Carleton, Mich.	Gen	Buc	1	240	514	5	10	12	4	A	S	.40	
Cadick Milling Co	Grandview, Ind.	Comp-Gen	Buc	1	240	514	5	10	12	4	A	S	.40	
Sinclair Refining Co	Mankins, Texas	Drill	Sup	1	240	514	6	9	12	4	A	S	....	
Wm E Wright & Sons Co	West Warren, Mass.	Gen	Buc	1	240	514	5	10	12	4	A	S	.40	
L V Marks & Sons	Vanceburg, Ky.	Gen	Buc	1	240	514	5	10	12	4	A	S	.40	
Eveleth	Minnesota	CS Gen	FM	2	225	300	3	14	17	2	A	S	....	
Cobb & Drew, Inc	Plymouth, Mass.	Gen	Buc	1	210	450	5	10	12	4	A	S	.40	
Naval Air Base	Kodiak, Alaska	Gen	Atlas	1	210	360	6	10	13	4	A	S	.42	
Geyer Mfg Co	Rock Falls, Ill.	Gen	Buc	1	210	450	5	10	12	4	A	S	.40	
New Mechanics Laundry	Chicago, Ill.	Gen	Wau	1	200	950	6	7	8½	4	E	S	.54	170-D
Anthony M Meyerstein, Inc	New York, N. Y.	Gen	Atlas	2	200	514	6	9	10½	4	A	S	.43	
Dominion Drilling Co	Suffield, Canada	Drill	Wau	3	200	950	6	7	8½	4	G	S	.54	
Riva Bros	Greenfield, Calif.	Pump	Atlas	1	200	514	6	9	10½	4	A	S	.43	
Mill City Water & Light	Mill City, Ore.	Gen	Atlas	1	200	514	6	9	10½	4	A	S	.43	
Dravo Corp	Pittsburgh, Pa.	Gen	Atlas	1	200	514	6	9	10½	4	A	S	.43	
				1	165	514	5	9	10½	4	A	S	.43	
R L Stockton	Arvin, Calif.	Pump	Wau	1	200	950	6	7	8½	4	G	S	.54	
Westhoff Light & Power Co	O'Fallon, Mo.	Gen	Atlas	1	200	514	6	9	10½	4	A	S	.43	
Panama Ice Co	New Orleans, La.	Comp-Gen	Atlas	1	200	514	6	9	10½	4	A	S	.43	
Morgan City Corp	Morgan, Utah	Gen	Atlas	1	200	514	6	9	10½	4	A	S	.43	
R W Kaltenbach Corp	Cleveland, Ohio	Gen	Atlas	1	200	514	6	9	10½	4	A	S	.43	
Hudson Cotton Mills	Hudson, N. C.	Gen	Buc	1	190	514	4	10	12	4	A	S	.40	
Bassett Hardwood Mfg Co	Monticello, Ky.	Shaft	Buc	1	190	514	4	10	12	4	A	S	.40	
Heckle & Kellogg, Inc	Cape Charles, Va.	Shaft	Buc	1	187½	400	5	9½	14	4	A	S	.40	
Barton Mines, Inc	North Creek, N. Y.	Gen	Wor	1	180	600	6	8	10½	4	A	S	.41	
Dravo Corp (U S Navy)	Mare Island, Calif.	Crane	Ent	1	180	600	6	8	10	4	A	S	.39	
Delaware Alloy Forge Co	Philadelphia, Pa.	Gen	Wor	1	180	600	6	8	10½	4	A	S	.41	
Jos C Rhinehart	Elroy, Ariz.	Pump	FM	1	180	360	3	12	15	2	A	S	....	
Harcon Steel & Iron Co	Portland, Me.	Pump	FM	1	180	360	3	12	15	2	A	S	....	
Tidewater Pipeline Co	Pennsylvania	Pump	Wor	2	170	450	3	10¾	14½	4	A	S	.40	
Green Logging Co	Gold Bar, Wash.	Logger	Wau	1	170	1050	6	7	7	4	G	S	.54	
Standard Oil of Indiana	Council Bluff, Iowa	Pump	Wor	3	170	450	3	10¾	14½	4	A	S	.40	
K C Henning	Shafter, Calif.	Pump	Wau	1	169	1300	6	6¼	6½	4	G	S	.54	
Carter Oil Co	Lincoln, Kan.	Drill	Wau	1	169	1300	6	6¼	6½	4	G	S	.54	
M W Ray	Coquille, Ore.	Logger	Wau	1	169	1300	6	6¼	6½	4	E	S	.54	
Carter Oil Co	Noweaqua, Ill.	Drill	Wau	2	169	1300	6	6¼	6½	4	G	S	.54	
Tulsa	Oklahoma	Pump	Wau	1	169	1300	6	6¼	6½	4	G	S	.54	
Sharon Drilling Co	Ellenwood, Kan.	Drill	Wau	2	169	1300	6	6¼	6½	4	G	S	.54	
Mack Toutsch	Burney, Calif.	Sawmill	Atlas	1	165	514	5	9	10½	4	A	S	.43	
Naval Air Base	Olongapo, P. I.	Gen	Atlas	1	165	514	5	9	10½	4	A	S	.43	
Union Potash & Chem Co	Carlsbad, N. Mex.	Comp	Atlas	1	165	514	5	9	10½	4	A	S	.43	
Boston Met Water Dist	Boston, Mass.	Pump	Atlas	1	165	514	5	9	10½	4	A	S	.43	
Bell Milling Co	Marianna, Fla.	Gen	FM	1	150	300	2	14	17	2	A	S	....	
Clanton Ice Co	Clanton, Ala.	Comp	FM	1	150	300	2	14	17	2	A	S	....	
Certified Ice Co	St. Paul, Minn.	Comp	FM	1	150	300	2	14	17	2	A	S	....	
Half Moon Gin Co	Dell, Ark.	Gin	FM	1	150	300	2	14	17	2	A	S	....	
Wabash Portland Cement Co	Osborn, Ohio	Comp	Wor	2	150	600	5	8	10½	4	A	S	.41	
Orcas Power & Light Co	East Sound, Wash.	Gen	Wor	1	150	514	6	8	10½	4	A	S	.41	
Rural Electrification Ad	Virgin Islands	Gen	Wor	3	150	600	5	8	10½	4	A	S	.41	
Wisconsin Oil Co	Sheboygan, Wis.	Pump	Wor	1	150	400	3	10¾	14½	4	A	S	.40	
Belle Springs Crystal Co	Belle Springs, Kan.	Comp & Gen	Buc	2	145	514	3	10	12	4	A	S	.40	
Barrowman Coal Co	Praise, Ky.	Gen	Buc	1	145	514	3	10	12	4	A	S	.40	
Mt Gallant Ice & Fuel	Mt Gallant, N. C.	Shaft	Buc	1	145	514	3	10	12	4	A	S	.40	
B J Co	Fairbanks, Alaska	Pump, Gen	Atlas	2	135	514	4	9	10½	4	A	S	.43	
Ohio Bell Telephone Co	Middletown, Ohio	Gen	Sup	1	135	700	6	7	9	4	A	S	....	
	Steubenville, Ohio	Gen	Sup	1	135	700	6	7	9	4	A	S	....	
Fairmont Lamp Co	Philadelphia, Pa.	Gen	Sup	1	130	600	3	9	12	4	A	S	....	
Wisconsin Oil Co	Sheboygan, Wis.	Pump	Wor	1	125	514	5	8	10½	4	A	S	.41	
Earl Hoyle	Churdan, Iowa	Mill	Wau	1	124	1400	6	5¼	6	4	E	S	.54	
Bartex International Corp	New York, N. Y.	Gen	Atlas	1	120	650	6	7	8½	4	A	S	.43	
Industrial Brownhoist Corp	Bay City, Mich.	Crane	FM	3	120	1200	6	5½	7½	4	E	S	....	
Franco Italian Pckg Co	Terminal Island, Calif.	Gen	Ent	1	120	600	4	8	10	4	A	S	.39	
Bureau of Prisons	Manila, P. I.	Gen	Atlas	2	120	360	3	10½	13	4	A	S	.42	
Northern Ohio Co	Parkin, Ark.	Gin	FM	1	120	360	2	12	15	2	A	S	....	
Western Boat Bldg Co	Tacoma, Wash.	Gen	Atlas	2	120	650	6	7	8½	4	A	S	.43	
Emerson Gin Co	Morley, Mo.	Gin	FM	1	120	360	2	12	15	2	A	S	....	
Pioneer Garage	Jordan, Mont.	Gen	FM	1	120	360	2	12	15	2	A	S	....	
Manuel Machada	San Francisco, Calif.	Gen	Sup	2	120	620	6	7	9	4	A	S	....	
Joe Rose & Frank Anjo	San Francisco, Calif.	Gen	Sup	2	120	620	6	7	9	4	A	S	....	
Ohio Locomotive Crane Co	Bucyrus, Ohio	Crane	FM	3	120	1200	6	5½	7½	4	E	S	....	

Typical Gas-Engine Installations

338 Engines Installed or Purchased Since April 1, 1940

Owner	Location	Equipt Driven	Engine builder	No. units	Hp.	Speed, rpm	No. cyl	Cyl bore	Cyl stroke	Vertical or horizontal	Cycle	Btu per hp hr	Type of fuel
Greenville	Texas	CS Gen	Nord	1	2400*	225	6	21½	29	..	2	.....	Nat
Potash Co of America	Carlsbad, N. Mex	Gen	Nord	1	2400*	225	6	21½	29	..	2	.....	Nat
Louisiana Ice & Electric Co	Bunkie, La	Gen	Wor	1	2160	257	12	20	25	V	4	9,000	Nat
Universal Atlas Cement Co	Atco, Texas	Gen	Nord	3	2000*	225	5	21½	29	..	2	.....	Nat
Jamaica Sewage Works	New York, N. Y	Gen	Wor	3	1440	257	8	20	25	V	4	9,000	Sew
General Public Utilities	New Iberia, La	CS Gen	Wor	1	1425	327	12	16	20	V	4	9,500	Nat
Southern Natural Gas Co	Pickens, Miss	Comp	Wor	2	1300	125	4	24	36	H	4	9,500	Nat
United Fuel Gas Co	Kerova, W. Va	Comp	Wor	1	1300	125	4	24	36	H	4	9,500	Nat
Mich. Gas Trans. Corp	Montezuma, Ind	Comp	Wor	1	1300	125	4	24	36	H	4	9,500	Nat
Panhandle Eastern Pipeline Co	Pearson Hill, Ind	Comp	Wor	1	1300	125	4	24	36	H	4	9,500	Nat
Southern Natural Gas Co	Reform, Ala	Comp	Wor	1	1300	125	4	24	36	H	4	9,500	Nat
Northern Natural Gas	Beatrice, Nebraska	Comp	Wor	1	1300	125	4	24	36	H	4	9,500	Nat
	Bashton, Kan	Comp	Wor	1	1300	125	4	24	36	H	4	9,500	Nat
Brownfield	Texas	CS Gen	Wor	1	1200	225	8	20	25	V	4	9,000	Nat
Public Utility & Engrg Service	Woodward, Okla	Gen	Nord	1	1125*	257	5	17	25	V	2	.....	Nat
Union Oil Co of Calif	Oleum, Calif	Comp	Clark	3	1000	350	8	14	14	V	2	10,000	.....
				2	375	350	3	14	14	V	2	10,000	.....
Memphis Natural Gas Co	Guthrie, La	Comp	Clark	1	1000	350	8	14	14	V	2	10,000	.....
Washington Gas Light Co	Washington, D. C	Comp	Clark	1	1000	350	8	14	14	V	2	10,000	.....
				2	800	300	8	14	14	V	2	10,000	.....
				1	1000	350	8	14	14	V	2	10,000	.....
Continental Oil Co	Villa Platte, La	Comp	Clark	1	400	300	4	14	14	V	2	10,000	.....
Peoples Water & Gas Co	Miami Beach, Fla	Comp	Clark	1	1000	350	8	14	14	V	2	10,000	.....
Coney Island Sewage	New York, N. Y	Gen	Wor	3	920	327	8	16	20	V	4	9,500	Sew
Virginia Gas Trans Corp	Gala, Va	Comp	Wor	1	900	150	4	20	30	H	4	9,500	Nat
Robstown	Texas	CS Gen	Sup	2	900	360	8	14½	20	..	4	.....	.....
Cities Service Oil Co	Odessa, Texas	Comp	Clark	1	800	300	8	14	14	V	2	10,000	.....
		Comp	Clark	3	600	300	6	14	14	V	2	10,000	.....
		Pump	Clark	1	120	514	4	9	11	V	4	10,000	.....
La Gloria Corp	Corpus Christi, Texas	Comp	Clark	9	800	300	8	14	14	V	2	10,000	.....
Hamman Exploration Co	Bay City, Texas	Comp	Clark	2	800	300	8	14	14	V	2	10,000	.....
Kentucky-W. Va. Gas Co	Ashland, Ky	Comp	Clark	2	800	300	8	14	14	V	2	10,000	.....
Bowery Bay Sewage Plant	New York	Gen	RJ	2	788	300	7	15½	22	V	4	.....	Sew
Canadian River Gas Co	Dalhart, Texas	Comp	Clark	1	600	300	6	14	14	V	2	10,000	.....
Gasoline Plant Const Corp	Arkansas Pass, Texas	Comp	Wor	1	625	300	5	15	15	V	2	10,000	Nat
Colorado Interstate Gas Co	Colorado Springs, Colo	Comp	Wor	2	625	300	5	15	15	V	2	10,000	Nat
Mississippi River Fuel Corp	Perryville, La	Comp	Wor	4	625	300	5	15	15	V	2	10,000	Nat
Arkansas Fuel Oil Co	Shreveport, La	Comp	Wor	1	625	300	5	15	15	V	2	10,000	Nat
Humble Oil & Refining Co	Baytown, Texas	Comp	Clark	4	600	300	6	14	14	V	2	10,000	.....
				6	500	300	5	14	14	V	2	10,000	.....
Continental Oil Co	Sam Fordyce, Texas	Comp	Clark	2	600	300	6	14	14	V	2	10,000	.....
Phillips Petro Co	Schuler Field, Texas	Comp	Clark	4	600	300	6	14	14	V	2	10,000	.....
W R Davis Co, Inc	Alice, Texas	Comp	Clark	1	600	300	6	14	14	V	2	10,000	.....
Cotton Valley Operators Com	Cotton Valley, La	Comp	Clark	12	600	300	6	14	14	V	2	10,000	.....
Panhandle Eastern Pipeline Co	Tuscola, Ill	Comp	Clark	1	600	300	6	14	14	V	2	10,000	.....
Bountiful	Utah	CS Gen	Wor	1	600	360	6	15	17½	V	4	9,500	Nat
Livingston	Texas	CS Gen	Wor	1	600	360	6	15	17½	V	4	9,500	Nat
Texoma Natural Gas Co	Stinnett, Texas	Gen	Wor	2	600	360	6	15	17½	V	4	9,500	Nat
East Ohio Gas Co	Cleveland, Ohio	Comp	Clark	2	600	300	6	14	14	V	2	10,000	.....
				1	500	350	4	14	14	V	2	10,000	.....
Lockhart Oil Co	San Antonio, Texas	Comp	Clark	2	600	300	6	14	14	V	2	10,000	.....
United Fuel Gas Co	Charleston, W. Va	Comp	Clark	8	600	300	6	14	14	V	2	10,000	.....
New Mexico Gas Co	Aztec, N. Mex	Comp	Clark	1	600	300	6	14	14	V	2	10,000	.....
Westchester Lighting Co	Mt. Vernon, N. Y	Comp	Wor	1	540	327	6	15	17½	V	4	9,500	.....
Oklahoma Electric & Water Co	Guymon, Oklahoma	Gen	Wor	1	540	327	6	15	17½	V	4	9,500	Nat
Manufacturers Gas Co	Brookville, Pa	Comp	Clark	2	500	300	5	14	14	V	2	10,000	.....
E B Badger & Sons Co	Boston, Mass	Comp	Wor	3	500	300	4	15	15	V	2	10,000	Nat
Southern Minerals	Corpus Christi, Tex	Comp	Clark	1	500	300	5	14	14	V	2	10,000	.....
Manufacturers Light & Heat Co	Elwood City, Pa	Comp	Clark	2	500	300	5	14	14	V	2	10,000	.....
The Texas Co	Salem, Ill	Comp	Clark	3	500	300	5	14	14	V	2	10,000	.....
Republic Production Co	Silsbee, Texas	Comp	Clark	1	500	300	5	14	14	V	2	10,000	.....
				2	300	300	3	14	14	V	2	10,000	.....
Geier Bros Inc, & Jackson	Grapeland, Texas	Comp	Clark	2	500	300	5	14	14	V	2	10,000	.....
Glen Rose Gasoline Co	Oklahoma City, Okla	Comp	Clark	2	500	300	5	14	14	V	2	10,000	.....
Continental Oil Co	Griffin, Indiana	Gen	Wor	3	400	450	6	12¼	14½	V	4	9,500	Nat
Birmingham Gas Co	Birmingham, Ala	Comp	Clark	1	400	300	4	14	14	V	2	10,000	.....
Public Service Co of N Ill	Skokie, Ill	Comp	Clark	1	400	300	4	14	14	V	2	10,000	.....
Chandler-Canfield-Midway Oil Co	Ventura, Calif	Gen	Sup	4	400	400	8	12½	16½	..	4	.....	.....
Warren Petroleum Co	Selmaville, Ill	Comp	Clark	5	400	300	4	14	14	V	2	10,000	.....
Tidewater Associated Oil Co	Bayonne, N. J	Comp	Clark	4	400	300	4	14	14	V	2	10,000	.....
Dominguez Water Corp	Los Angeles, Calif	Gen	Wor	3	385	428	6	12¼	14½	V	4	9,500	.....
Godfrey L Cabot Co	Charleston, W. Va	Comp	Clark	1	375	350	3	14	14	V	2	10,000	.....
				1	300	300	3	14	14	V	2	10,000	.....
R C Lipscomb Drilling Co	Henrietta, Texas	Drill	Wau	2	374	900	6	8½	8½	V	4	10,500	Nat
Richfield Oil Co	Los Angeles, Calif	Drill	Wau	1	374	900	6	8½	8½	V	4	10,500	But
Field and Nagles	Okemah, Okla	Pump	Wau	1	374	900	6	8½	8½	V	4	10,500	But
R E Havenstrite	Los Angeles, Calif	Drill	Wau	2	374	900	6	8½	8½	V	4	10,500	Nat
Panhandle Eastern Pipe Line Co	Liberal, Kan	Gen	IR	1	370	400	8	11	13½	V	4	10,000	Nat
Cotton Valley Association	Cotton Valley, La	Gen	IR	4	370	400	8	11	13½	V	4	10,000	Nat
		Pump	IR	3	185	400	4	11	13½	V	4	10,000	Nat
Federal Reserve Bank	Kansas City, Mo	Gen	IR	3	370	400	8	11	13½	V	4	10,000	Nat
Louisiana Canal Co	Iowa, La	Pump	Wor	1	360	400	6	12¼	14½	V	4	9,500	Nat
Jarbee Co	Freer, Texas	Gen	BM	1	350	277	4	16½	17	V	4	10,000	Nat
Old Colony Gas Co	Braintree, Mass	Comp	Wor	1	300	350	8	11½	12	V	4	10,000	.....
				1	225	350	6	11½	12	V	4	10,000	.....
Western United Gas & Electric	Aurora, Ill	Comp	Wor	1	300	350	8	11½	12	V	4	10,000	Nat
Niagara Oil Corp	Bradford, Pa	Comp	Clark	1	300	300	3	14	14	V	2	10,000	.....
The Texas Co	Lockport, Ill	Comp	Clark	1	300	300	3	14	14	V	2	10,000	.....
Columbian Fuel Corp	Sharondale, Ky	Comp	Clark	2	300	300	3	14	14	V	2	10,000	.....
Warren Petroleum Corp	Galva, Kan	Comp	Wor	1	300	350	8	11½	12	V	4	10,000	Nat
Oilfield Construction Co	Long Beach, Calif	Comp	Wor	2	300	350	8	11½	12	V	4	10,000	Nat
Standard Oil Co of Indiana	Baton Rouge, La	Comp	Wor	10	300	350	8	11½	12	V	4	10,000	.....
				2	225	350	6	11½	12	V	4	10,000	.....
				1	150	350	4	11½	12	V	4	10,000	.....
Magnolia Petroleum Corp	Fort Worth, Texas	Comp	Wor	2	300	350	8	11½	12	V	4	10,000	Nat
				1	75	350	2	11½	12	V	4	10,000	Nat
Boston Consolidated Gas Co	Allston, Mass	Comp	Clark	1	300	300	3	14	14	V	2	10,000	.....
Shell Oil Co, Inc	Roxana, Ill	Comp	Clark	1	300	300	3	14	14	V	2	10,000	.....
Hope Natural Gas Co	Hastings, W. Va	Comp	Clark	1	300	300	3	14	14	V	2	10,000	.....
Lion Oil Refining Co	Pearson, Ark	Comp	Wor	1	300	350	8	11½	12	V	4	10,000	.....

Diesel Installations Under 115 Hp

Owner	Location	Equipt. driven	Engine builder	No. units	Hp each	Rpm	No. cyl	Bore	Stroke	Starting method
Sanford Milling Co	Sanford, N. C.	Shaft	Buc	1	112½	400	3	10	12	A
Rytex Co	Indianapolis, Ind.	Gen	Buc	1	112½	400	3	9½	14	A
Bristol Bay Mining	Seattle, Wash.	Pump	Atlas	1	105	650	6	6½	8½	A
Arthur Duvic's Sons	New Orleans, La.	Pump	Atlas	1	105	650	6	6½	8½	A
Maiden Flour Mills	Maiden, N. C.	Shaft	Buc	1	100	600	4	7½	10½	A
G Rapids Dinette Co	G Rapids, Mich	Gen	Buc	1	100	514	5	7⅛	10½	A
Hatteras Develop Co	Hatteras, N. C.	Gen	Buc	1	100	600	4	7½	10½	A
Southn Mica Co	Johnson City, Tenn.	Shaft	Buc	1	100	600	4	7½	10½	A
Beaufort Ice Co	Beaufort, N. C.	Comp	Buc	1	100	514	5	7½	10½	A
Lee County Co-op	Ft Meyers, Fla.	Gen	Sup	1	100	600	5	7	9	A
Broadway Ice Co	Tampa, Fla.	Comp	Buc	1	100	600	4	7½	10½	A
Raymond Price	Prophetstown, Ill.	Mill	Wau	1	98	1500	6	4½	5½	E
J Marchesi Coal	New Philadelphia, O.	Gen	FM	1	90†	450	3	8¾	10½	A
Maple Creamery	St Benifius, Minn.	Gen	FM	1	90†	450	3	8¾	10½	A
Bayside Oil Co	Morgan City, La.	Gen	FM	1	90	900	6	5½	7½	E
Ira S Bushey Co	New York, N. Y.	Pump	Atlas	10	80	650	4	7	8½	A
Anderson & Hodden	Lancaster, Cal.	Pump	Wau	1	80	1050	4	6	6½	H
R E Warren	Howell, Mich.	Mill	Wau	1	80	1050	6	6	6½	H
E J Evans	Lancaster, Cal.	Pump	Wau	1	80	1050	4	6	6½	H
Interstate Oil Trans Co	Phila, Pa.	Pump	Atlas	1	80	650	4	7	8½	A
New Holland Brass, Bronze & Aluminum Co	New Holland, Pa.	Comp	Buc	1	75	600	3	7½	10½	A
S S Kresge Co	Ridgewood, N. Y.	Gen	Lis	2	70	420	1	11¾	15½	A
Refined Macaroni Co	Brooklyn, N. Y.	Gen	Lis	1	70	420	1	11¾	15½	A
Brunswick Coca-Cola	Brunswick, Mo.	Comp	Buc	1	67½	360	2	9½	14	A
Bethlehem Steel Co	Jonestown, Pa.	Pump	Wor	1	60	600	2	8	10½	A
Howard Nye	Dixon, Mont.	Pump	FM	1	60	1200	6	4¼	6	E
Washington	Missouri	Pump	Wor	1	60	600	2	8	10½	A
Keystone Laundries	Asbry Park, N. J.	Gen	FM	2	60†	450	2	8¾	10½	A
Valentine Trans Co	New York, N.Y.	Pump	Atlas	1	60	700	4	6	8	A
Work Press Cloth Co	New Orleans	Shaft	FM	1	60†	450	2	8¾	10½	A
Campbell Mach Co	San Diego, Cal.	Gen	Atlas	1	50	650	3	6½	8½	A
N V V Franchot	Olean, N. Y.	Pump	Clark	2	40†	200	1	12½	16	A
Campbell Mach Co	San Diego, Cal.	Gen	FM	2	40	1200	4	4¼	6	E
Cornell S S Co	Kingston, N. Y.	Gen	Lis	2	40	1200	4	4½	5½	H
O Hillman Co	N Attleboro, Mass.	Shaft	Lis	1	37	500	1	8¾	13	A
Texas Tech	Lubbock, Texas	Comp	Lis	1	37	500	1	8¾	13	A
(Salmon Cannery)	Alaska	Gen	Lis	1	30	1200	3	4½	5½	H
Levingston Shipyard	Orange, Tex.	Gen	Lis	3	30	1200	3	4½	5½	H
Ecland Body Works	Minneapolis	Gen	Shep	1	25	1200	3	4	5	E
Dutchland Restrnt	Milford, Conn.	Gen	Shep	1	25	1200	3	4	5	E
C H Hershock	Harrisburg, Pa.	Gen	Shep	1	25	1200	3	4	5	E
Lorenz Co	Klamath Falls, Ore.	Gen	FM	1	20	1200	2	4¼	6	E
Stanny Market	Detroit, Mich.	Gen	Lis	1	20	1200	2	4½	5½	H
Carl's Duck Farm	Saugus, Mass.	Gen	Lis	2	19	540	1	7¼	9½	H
Spinning Wheel	Wickford, R. I.	Gen	Lis	2	18	450	1	7¼	9½	H
Shaver Trans Co	Seattle, Wash.	Gen	Lis	1	16	1200	2	4½	4⅝	H
Honeycutt Const Co	Tampa, Fla.	Gen	Lis	1	12	650	2	4½	5½	H
Menhaden Products	Reedville, Va.	Gen	Lis	4	12	650	2	4½	5½	H
Hotel Stratford	Alton, Ill.	Gen	Lis	2	12	650	2	4½	5½	H
Orlando Cold Storage	Orlando, Fla.	Comp	Lis	1	12	650	2	4½	5½	H
Bradenton Garage	Bradenton, Fla.	Gen	Lis	1	12	650	2	4½	5½	H
Platzer Boat Works	Houston, Tex.	Gen	Lis	1	12	650	2	4½	5½	H
Barker Barge Line	Lockport, La.	Gen	Lis	1	12	650	2	4½	5½	H
Trask & Johnson	Arlington, Mass.	Gen	Lis	1	12	650	2	4½	5½	H
Cosy Corner Grill	New York, N. Y.	Gen	Lis	1	12	650	2	4½	5½	H
Atlanta & St And R R	Fountain, Fla.	Pump	Lis	1	6	650	1	4½	5½	H

Gas-Engine Installations Under 300 Hp

Owner	Location	Equipt. driven	Engine builder	No. units	Hp each	Rpm	No. cyl	Bore	Stroke
Dymo Oil Corp	Litchfield, Ohio	Gen	IR	1	275	400	6	11	13½
Meridan	Miss.	Pump	Wor	1	260	320	3	15	17½
Magnolia Pipeline Co	Marlow, Okla.	Pump	LeRoi	1	250	900	12	6¾	7
	Alice, Texas	Pump	LeRoi	1	250	900	12	6¾	7
Amer-Mich. Pline Co	B Rapids, Mich.	Comp	Wor	1	225	350	6	11½	12
Coronado Corp	Woodsboro, Texas	Pump	IR	1	225	350	6	11	12½
Old Colony Gas Co	Braintree, Mass.	Comp	Wor	1	225	300	8	11½	12
Pennsylvania Gas Co	Erie, Pa.	Comp	Wor	1	225	350	6	11½	12
Pure Oil Co.	Cabin Creek, W. Va.	Pump	Wor	1	215	450	3	12¼	14½
R C Lipscomb Drill Co	Holliday, Tex.	Drill	Wau	2	213	950	6	7	8½
Gardner Bros Drill Co	Sundown, Tex.	Drill	Wau	2	213	950	6	7	8½
J R Sharp Drill Co	Sundown, Tex.	Drill	Wau	2	213	950	6	7	8½
				2	193	1300	6	6¼	6½
Fruit Industries	Los Angeles, Cal.	Comp	Wau	1	213	950	6	7	8½
Denver Drilling Co	Holliday, Tex.	Drill	Wau	2	213	950	6	7	8½
Stanolind Co, Kadan Corners	Tex.	Pump	Wau	1	213	950	6	7	8½
Allen Drilling Co	Russell, Kan.	Drill	Wau	1	213	950	6	7	8½
Wichita Lndry	Wichita Falls, Tex.	Gen	BM	1	210	277	4	13½	15
Peoples Nat Gas Co	Pittsburgh, Pa.	Comp	Clark	1	200†	200	2	16	20
West Texas Gas Co	Tahoka, Tex.	Comp	Clark	1	200†	300	2	14	14
Sallee Brothers	Centralia, Ill.	Pump	Wau	1	195	1050	6	7	7
A Kingery Drilling	Ada, Okla.	Drill	Wau	2	193	1300	6	6¼	6½
Athletic M & S Co	Fort Smith, Ark.	Blower	Wau	1	193	1300	6	6¼	6½
Skelly Oil Co	Seminole, Okla.	Pump	Wau	2	193	1300	6	6¼	6½
Elk Valley Alf Mill	Independ., Kan.	Mill	Wau	1	193	1300	6	6¼	6½
Streamline Drill Co	Konowa, Okla.	Pump	Wau	1	193	1300	6	6¼	6½
J E Farrell	Wichita Falls, Tex.	Drill	Wau	2	193	1300	6	6¼	6½
Claude Wentworth	Russell, Kan.	Drill	Wau	2	193	1300	6	6¼	6½
Wixson Drilling Co	Winfield, Kan.	Drill	Wau	1	193	1300	6	6¼	6½
Slim Hampton, Inc	Mount. View, Cal.	Hoist	Wau	1	193	1300	6	6¼	6½
Pure Oil Co	Madill, Okla.		Wau	1	193	1300	6	6¼	6½
Gnrl Geophys. Co	Falls City, Neb.	Drill	Wau	1	193	1300	6	6¼	6½
Cont Oil Co	Ponca City, Okla.	Gen	Wor	1	180	514	6	9	10½
N Natural Gas Co	Skellytown, Tex.	Gen	Wor	1	180	514	6	9	10½
Brown Cr & Candy Co	Dallas, Tex.	Gen	BM	1	180	514	6	9	10½
Hidalgo Water Control	McAllen, Tex.	Pump	BM	1	180	514	6	9	10½
Mich. Gas Trans Corp	Edgerton, Ind.	Gen	Wor	2	180	514	6	9	10½
Natch. Oil Mill	Natchitoches, La.	Gen	BM	1	170	277	4	12¼	15
Fitzsimmons Hospital	Bunell, Colo.	Gen	LeRoi	1	165	1200	6	6¾	7
Wrstr Gas Co	Worcester, Mass.	Comp	Clark	1	165†	300	2	13	14
Latonia Refining Co	Latonia, Ky.	Comp	Clark	1	165†	300	2	13	14
N Natural Gas Co	Bushton, Kan.	Gen	Wor	1	150	514	5	9	10½
Edinburg Ice Co	Edinburg, Tex.	Comp	BM	2	150	200	4	13½	15
C F Braun & Co	Alhambra, Cal.	Comp	Wor	2	150	350	4	11½	12
Camp Shelby	Hattiesburg, Miss.	Blowr	Wor	1	150	514	5	9	10½
J R Duncan Ice Co	Chickasha, Okla.	Comp	BM	1	145	360	4	11	12
Lupher Drilling Co	Fairfield, Ill.		Wau	1	136	1400	6	5½	5½
Union Oil Co	S Fe Springs, Cal.	Pump	Wau	1	136	1400	6	5½	5½
	Signal Hill, Cal.	Pump	Wau	1	104	1500	6	5¼	6
Midcont. Petrol. Co	Stillwater, Okla.	Pump	Wau	1	136	1400	6	5½	5½
Gnrl Petrol. Oil Co	Ventura, Cal.	Pump	Wau	1	136	1400	6	5½	5½
Stndrd Well Serv	Okla City, Okla.	Drill	Wau	1	136	1400	6	5½	5½
Smith Oil Co	Bradford, Pa.	Pump	Wau	1	136	1400	6	5¼	6
Howard Brunson	Claflin, Kan.		Wau	1	136	1400	6	5½	5½
Oklahoma Baptist U	Shawnee, Okla.	Gen	Wau	2	136	1400	4	5½	5½
Hammond Lmbr Co	Los Angeles, Cal.	Gen	NTP	1	130	720	8	6	9
Okla City Market	Okla City, Okla.	Gen	NTP	2	130	720	8	6	9
				1	50	720	3	6	9
Harlow Gin Assn	Harlow, Miss.	Gin	LeRoi	1	130	1060	6	6	7
McAllen Ice Co.	McAllen, Tex.	Comp	BM	1	126	360	6	9	10½
		Gen	BM	1	84	360	4	9	10½
Edinburg Ice Co	Edinburg, Tex.	Gen	BM	2	100	300	2	13½	15
Prosper Co-op Gin Co	Frisco, Tex.	Gin	LeRoi	1	125	900	6	6¾	7
Tillman & Mahaffey	Mt Vernon, Tex.	Gin	LeRoi	1	125	900	6	6¾	7
Kirkpatrick Gin	Ennis, Tex.	Gin	LeRoi	1	125	1010	6	6	7
Blaydes Gin	Blaydes, Okla.	Gin	LeRoi	2	125	900	6	6¾	7
Sthn Nat Gas Co	DeArmanville, Ala.	Gen	BM	1	120	514	4	9	10½
Intersection Co	Los Angeles, Cal.	Gen	NTP	1	110	600	8	6	9
Natl Petrol. Co	Pleasantville, Pa.	Gen	NTP	1	110	600	8	6	9
Red Valley Oil Co	Pithole, Pa.	Gen	NTP	2	110	600	8	6	9
St Petersburg	Fla.	Blower	Wor	1	105	600	3	9	10½
Bridger Val. Elect	Mount View, Wyo.	Gen	Wor	2	105	600	3	9	10½
Ind. Ice & Ref. Co	Abilene, Tex.	Comp	BM	2	96	550	3	9	10½
Union Ice & Fuel, Colo. Springs	Colo.	Comp	BM	1	90	300	2	12¼	15
Gilbert Bros, Casa Grande	Ariz.	Pump	Wor	1	90	720	6	6½	7½
Carroll Mills, Carrollton	Ga.	Gen	BM	1	90	514	3	9	10½
Kan. Pckg Mrktg, Hutchinson	Kan.	Comp	BM	1	90	514	3	9	10½
Borden Co, Waco, Texas		Comp	BM	1	80	460	3	9	10½
Superior Oil Co., Albion, Ill.		Pump	Wau	1	79	1050	4	6	6½
Mfgs Lt & Heat, Elwood City, Pa.		Gen	Wor	2	75	720	5	6½	7½
Mercer Water Co, Mercer, Pa.		Pump	BM	1	70	400	3	9	10½
Sun Oil Co, Crossville, Ill.		Pump	Wau	1	66	1600	6	4¼	4¾
Va. Gas Trans Corp, Gala, Va.		Gen	Wor	2	60	720	4	6½	7½
Pryor and Lockhart, Holyrood, Kan.		Pump	Wau	1	50	1400	4	4½	5½
Wagner Baking Co, Chicago, Ill.		Comp	Wau	1	50	1400	4	4½	5½
W C Emerich, Holyrood, Kan.		Pump	Wau	1	50	1400	4	4½	5¼
Gulf Oil Corp	Three Sands, Okla.	Pump	LeRoi	2	50	1000	4	5	6
	Centralia, Ill.	Pump	LeRoi	2	20	1100	4	3¼	4
Barnsdall Oil Co, Odessa, Texas		Pump	LeRoi	1	50	1000	4	5	6
Huron, S. Dakota		Gen	Wor	1	45	720	3	6½	7½
Cleve Gskt & Mfg Co, Cleveland, O.		Gen	BM	1	45	360	2	9	11
Antlers, Oklahoma		Pump	LeRoi	1	40	1200	4	4½	6
				1	20	1200	4	3¼	4
Quincy, Illinois		Pump	LeRoi	2	40	850	4	4½	6
Messer Oil Corp, Olean, N. Y.		Pump	Clark	1	40†	200	1	12½	16
N V V Franchot, Olean, N. Y.		Pump	Clark	1	40†	200	1	12½	16
Bovaird & Co., Bradford, Pa.		Pump	Clark	1	40†	200	1	12½	16
South Penn Oil Co., Bradford, Pa.		Pump	Clark	3	40†	200	1	12½	16
Twin Hills C C, Okla City, Okla.		Pump	LeRoi	1	40	1150	4	4½	6
Superior Oil Co, Grose Tete, La.		Gen	Wau	1	33	1800	4	3⅝	4½
Otsquago Corp, Cuba, N. Y.		Pump	Clark	1	30†	600	2	5¾	7
U of Sthn Cal., Los Angeles, Cal.			NTP	1	27	600	2	6	9
Culinart Products, Chicago, Ill.		Comp	Wau	1	25	1800	4	3¼	4

ABBREVIATIONS—Atlas—Atlas-Imperial, BM—Bruce-MacBeth, Buc—Buckeye, Clark—Clark Bros, FM—Fairbanks Morse, IR—Ingersoll-Rand, LeRoi—LeRoi, Lis—Lister-Blackstone, Nord—Nordberg, NTP—National Transit Pump, RJ—Rathbun-Jones, Shep—Sheppard, Sup—Superior (National Supply Co), Wau—Waukesha, Wor—Worthington. NOTE—Most units driving compressors are integral machines.

Under type of fuel, gas-engine tabulation: But—butane, City—city gas, Nat—natural gas, Prop—propane, Ref—refinery gas, Sew—sewage gas.

Under starting method, list of diesel installations under 115 hp: A is air, E is electric, G is gasoline, H is hand.

*Operate on full diesel cycle; †2-cycle engines, others 4-cycle.

Diesel Manufacturers & Suppliers

AMERICAN DIESEL ENGINE CORP
1156 Main St., Melrose, Mass.

(No data available)

AMERICAN LOCOMOTIVE CO
Diesel Engine Div, Auburn, N. Y.

2-cycle vertical
4–6 cyl, 720–1080 hp @ 277 rpm, 14 x 23½
8 cyl, 1440 hp @ 277 rpm, 14 x 23½

4-cycle vertical
6 & 8 cyl, 540–720 hp @ 600 rpm, 12½ x 13
*6 cyl, 810 hp @ 600 rpm, 12½ x 13
5 & 6 cyl, 730–875 hp @ 257 rpm, 17½ x 25
8 cyl, 1170 hp @ 257 rpm, 17½ x 25
* Exhaust turbo-pressure supercharged (Buchi)

ANDERSON DIESEL ENGINE CO
Philadelphia, Pa.

2-cycle vertical
1-4 cyl, 50–200 hp @ 257 rpm, 12½ x 18
6 cyl, 300 hp @ 257 rpm, 12½ x 18
1-4 cyl, 60–240 hp @ 257 rpm, 14 x 18
6 cyl, 400 hp @ 257 rpm, 14 x 18
1-4 cyl, 30–120 hp @ 277 rpm, 10 x 14
6 cyl, 360 hp @ 277 rpm, 14 x 18

ATLAS-IMPERIAL DIESEL ENGINE CO
Oakland, Calif.

4-cycle vertical
3 & 4 cyl, 67½–90 hp @ 900 rpm, 6¼ x 8¼
6 cyl, 135 hp @ 900 rpm, 6¼ x 8¼
2-4 cyl, 35–70 hp @ 650 rpm, 6½ x 8½
6 cyl, 105 hp @ 650 rpm, 6½ x 8½
4 & 6 cyl, 80–120 hp @ 650 rpm, 7 x 8½
3 & 4 cyl, 60–80 hp @ 450 rpm, 7½ x 10½
6 cyl, 120 hp @ 450 rpm, 7½ x 10½
3 & 4 cyl, 65–90 hp @ 450 rpm, 8 x 10½
4–6 cyl, 135–200 hp @ 514 rpm, 9 x 10½
8 cyl, 275 hp @ 514 rpm, 9 x 10½
3 & 4 cyl, 90–120 hp @ 400 rpm, 9 x 12
6 cyl, 180 hp @ 400 rpm, 9 x 12
3 & 4 cyl, 105–140 hp @ 360 rpm, 10 x 13
6 cyl, 210 hp @ 360 rpm, 10 x 13
3 & 4 cyl, 120–160 hp @ 360 rpm, 10½ x 13
3 & 4 cyl, 150–200 hp @ 327 rpm, 11½ x 15
6 cyl, 300 hp @ 327 rpm, 11½ x 15
3 & 4 cyl, 200–265 hp @ 327 rpm, 13 x 16
6 cyl, 400 hp @ 327 rpm, 13 x 16
6 cyl, 450 hp @ 350 rpm, 13 x 16
6 cyl, 525 hp @ 300 rpm, 14½ x 18
6 cyl, 600 hp @ 300 rpm, 15 x 19

BALDWIN DE LA VERGNE SALES CORP
Paschall P O, Philadelphia, Pa.

4-cycle vertical
3-8 cyl, 210– 900 hp @ 360-600 rpm, 12¾ x 15½
4-8 cyl, 350– 760 hp @ 300-327 rpm, 15 x 18½
4-8 cyl, 460–1085 hp @ 300-360 rpm, 16 x 20
6-8 cyl, 750–1040 hp @ 257-277 rpm, 17 x 24
4-8 cyl, 500–1000 hp @ 240 rpm, 17½ x 24
4-8 cyl, 800–1600 hp @ 200 rpm, 22 x 30

4-cycle V-type
8 cyl, 750 hp @ 1050 rpm, 9½ x 9½

BOLINDERS COMPANY, INC
33 Rector St, New York, N. Y.

2-cycle vertical
1 & 2 cyl, 8 to 150 hp

BROMFIELD MANUFACTURING CO
211 Northern Ave., Boston, Mass.

2-cycle vertical
1-2 cyl, 12–25 hp @ 750 rpm, 4⅛ x 6¾
2 cyl, 50 hp @ 500 rpm, 6¾ x 9⅞

THE BUCKEYE MACHINE CO
Lima, Ohio

4-cycle vertical
3-5 cyl, 50–125 hp @ 600 rpm, 7½ x 10½
3-6 cyl, 168–337 hp @ 600 rpm, 10 x 12
6-8 cyl, 375–500 hp @ 600 rpm, 10½ x 12
4-6 cyl, 335–500 hp @ 400 rpm, 13½ x 15½
5-8 cyl, 560–900 hp @ 400 rpm, 14½ x 18

Listings are as complete and accurate as available information permits, but POWER assumes no responsibility for errors or omissions. Almost all listings supplied by manufacturers. Abbreviations are: cyl—cylinder, hp—horsepower, rpm—revolutions per minute. The two numbers at the end of each line are respectively bore and stroke in inches.

In listing the number of cylinders, the hyphen (5-8) means that intermediate numbers of cylinders give intermediate horsepower in even steps; the "and" sign (6 & 8) means that only the two sizes are available.

THE BUDA COMPANY
Harvey, Ill.

4-cycle vertical
4 cyl, 48 hp @ 2000 rpm, 3⅝ x 5⅛
4 cyl, 51 hp @ 2000 rpm, 3¾ x 5⅛
6 cyl, 63 hp @ 2000 rpm, 3⅝ x 4½
6 cyl, 67½ hp @ 2000 rpm, 3⅝ x 4¾
6 cyl, 71½ hp @ 2000 rpm, 3⅝ x 5⅛
6 cyl, 76 hp @ 1800 rpm, 3⅞ x 5½
6 cyl, 88½ hp @ 1700 rpm, 4¼ x 5½
6 cyl, 118 hp @ 1500 rpm, 4¾ x 6½
6 cyl, 140 hp @ 1300 rpm, 5¼ x 7
6 cyl, 196 hp @ 1100 rpm, 6¼ x 8¾
6 cyl, 212 hp @ 1100 rpm, 6½ x 8¾
6 cyl, 207 hp @ 1000 rpm, 6¾ x 8¾

BUSCH-SULZER BROS-DIESEL ENGINE CO
2nd & Utah Sts, St Louis, Mo.

2-cycle vertical
4-8 cyl, 700–1400 hp @ 300 rpm, 15⅛ x 21
4-10 cyl, 1360–3400 hp @ 240 rpm, 20½ x 27½

4-cycle vertical
3-8 cyl, 225– 666 hp @ 360–400 rpm, 13 x 17
3-8 cyl, 225– 666 hp @ 300-327 rpm, 13 x 20
4-8 cyl, 500–1090 hp @ 300-327 rpm, 16½ x 21
4-8 cyl, 500–1090 hp @ 257-277 rpm, 16½ x 24½

CATERPILLAR TRACTOR CO
Peoria, Ill.

4-cycle vertical
4 cyl, 17– 34 hp @ 800–1650 rpm, 3¾ x 5
4 & 6 cyl, 30– 82 hp @ 800–1600 rpm, 4¼ x 5½
4 & 6 cyl, 60– 90 hp @ 1800 rpm, 4¼ x 5½
4 & 6 cyl, 48–115 hp @ 550–1000 rpm, 5¼ x 8
4 & 6 cyl, 57–140 hp @ 550–1000 rpm, 5¾ x 8

4-cycle V-type
8 cyl, 108–190 hp @ 550–1000 rpm, 5¾ x 8

CHICAGO PNEUMATIC TOOL CO
6 E 44th St, New York, N. Y.

4-cycle vertical
3-8 cyl, 90– 380 hp @ 514–900 rpm, 8, 9 x 10½
3-8 cyl, 135– 450 hp @ 360–450 rpm, 10¾ x 14¼
3-8 cyl, 340–1000 hp @ 300-327 rpm, 16 x 20

CLARK BROTHERS COMPANY
Olean, N. Y.

2-cycle vertical
2-6 cyl, 175–525 hp @ 330 rpm, 13 x 14
8 cyl, 700 hp @ 330 rpm, 13 x 14

4-cycle vertical
3 cyl, 150–200 hp @ 600–720 rpm, 10 x 12
4 cyl, 200–265 hp @ 600–720 rpm, 10 x 12
6 cyl, 300–400 hp @ 600-720 rpm, 10 x 12
8 cyl, 400–535 hp @ 600–720 rpm, 10 x 12
Also angle diesel-engine compressor units and convertible pumping engines.

THE COOPER-BESSEMER CORP
Mt Vernon, Ohio.

2-cycle horizontal
1 & 2 cyl, 25–110 hp @ 180–327 rpm

4-cycle vertical
3, 4, 6, 8 cyl, 60– 400 hp @ 400–900 rpm, 8 x 10½
3, 4, 6, 8 cyl, 80– 475 hp @ 360–720 rpm, 9 x 12
3, 4, 6, 8 cyl, 120– 750 hp @ 360–750 rpm, 10½ x 13½
5-8 cyl, 325– 925 hp @ 325–514 rpm, 13 x 16
6-8 cyl, 250–1250 hp @ 225–350 rpm, 15½ x 22

CUMMINS ENGINE CO
Columbus, Ind.

4-cycle vertical
4 & 6 cyl, 67–100 hp @ 2200 rpm, 4 x 5
4 & 6 cyl, 100–150 hp @ 1800 rpm, 4⅞ x 6
*6 cyl, 200 hp @ 1800 rpm, 4⅞ x 6
6 cyl, 210 hp @ 1000 rpm, 6¾ x 9
6 cyl, 230 hp @ 1000 rpm, 7 x 9
6 & 12 cyl, 250–500 hp @ 1000 rpm, 7 x 10
*Supercharged.

ENTERPRISE ENGINE CO
San Francisco, Calif.

4-cycle vertical
3 cyl, 50– 90 hp @ 400–600 rpm, 8 x 10
4 cyl, 65– 120 hp @ 400–600 rpm, 8 x 10
6 cyl, 100– 200 hp @ 400–720 rpm, 8 x 10
4 cyl, 120– 210 hp @ 300–514 rpm, 10½ x 12
6 cyl, 180– 510 hp @ 300–850 rpm, 10½ x 12
8 cyl, 240– 680 hp @ 300–850 rpm, 10½ x 12
4 cyl, 120– 185 hp @ 300–450 rpm, 10 x 13
6 cyl, 170– 260 hp @ 300–450 rpm, 10 x 13
6 cyl, 290– 600 hp @ 300–600 rpm, 12 x 15
8 cyl, 385– 800 hp @ 300–600 rpm, 12 x 15
5 cyl, 375– 625 hp @ 200–327 rpm, 16 x 20
6 cyl, 450– 965 hp @ 200–420 rpm, 16 x 20
7 cyl, 525–1125 hp @ 200–420 rpm, 16 x 20
8 cyl, 600–1290 hp @ 200–420 rpm, 16 x 20
9 cyl, 675–1450 hp @ 200–420 rpm, 16 x 20
10 cyl, 750–1600 hp @ 200–420 rpm, 16 x 20

FAIRBANKS, MORSE & CO
600 S Michigan Ave, Chicago, Ill.

2-cycle vertical
2- 3 cyl, 60– 90 hp @ 450 rpm, 8¾ x 10½
1- 3 cyl, 60– 180 hp @ 360 rpm, 12 x 15
1- 6 cyl, 75– 450 hp @ 300 rpm, 14 x 17
5- 7 cyl, 500– 700 hp @ 400 rpm, 12 x 15
5- 7 cyl, 575– 805 hp @ 300 rpm, 14 x 17
4-10 cyl, 700–1750 hp @ 300 rpm, 16 x 20

4-cycle vertical
1-8 cyl, 10– 80 hp @ 1200 rpm, 4¼ x 6
4-8 cyl, 80–160 hp @ 1200 rpm, 5½ x 7½*
6-8 cyl, 225–300 hp @ 720 rpm, 8 x 10½*
*Convertible to gas
Also marine engines

FRANKLIN VALVELESS ENGINE CO
Franklin, Pa. (No data)

FULTON IRON WORKS CO
St Louis, Mo.

4-cycle vertical
3-8 cyl, 225– 600 hp @ 300 rpm, 13¾ x 18
4-8 cyl, 580–1160 hp @ 257 rpm, 17½ x 24½
4-8 cyl, 1000–2000 hp @ 225 rpm, 23 x 28

GENERAL MOTORS CORP
Diesel Engine Div, Detroit, Mich.

2-cycle vertical
1 cyl, 15 hp @ 1200 rpm, 4¼ x 5
3-4 cyl, 45–60 hp @ 1200 rpm, 4¼ x 5
6 cyl, 90 hp @ 1200 rpm, 4¼ x 5

Diesel Engine Div, Cleveland, Ohio

2-cycle V-type
6 cyl, 360– 435 hp @ 600–720 rpm, 8½ x 10
8 cyl, 470– 575 hp @ 600–720 rpm, 8½ x 10
12 cyl, 725– 865 hp @ 600–720 rpm, 8½ x 10
16 cyl, 940–1150 hp @ 600–720 rpm, 8½ x 10

4-cycle vertical
6 & 8 cyl, 150–200 hp @ 1200 rpm, 5½ x 7
3 cyl, 330– 365 hp @ 360– 400 rpm, 14 x 16
4 cyl, 500– 560 hp @ 360– 400 rpm, 14 x 16
6 cyl, 700– 750 hp @ 360– 400 rpm, 14 x 16
6 cyl, 650– 705 hp @ 277– 300 rpm, 15½ x 22
8 cyl, 870– 940 hp @ 277– 300 rpm, 15½ x 22
8 cyl, 1000–1150 hp @ 225– 257 rpm, 17 x 26

HERCULES MOTORS CORP
Canton, Ohio

4-cycle vertical
2 cyl, 24 hp @ 1800 rpm, 3¾ x 4½

HERCULES MOTORS CORP (con't)

2 cyl, 27.6 hp @ 1800 rpm, 4 x 4½
2 cyl, 27.6 hp @ 1600 rpm, 4¼ x 4½
4 cyl, 62 hp @ 2600 rpm, 3⅞ x 4½
4 cyl, 70 hp @ 2600 rpm, 4 x 4½
4 cyl, 79 hp @ 2600 rpm, 4¼ x 4½
6 cyl, 77 hp @ 2600 rpm, 3½ x 4½
6 cyl, 83 hp @ 2600 rpm, 3¾ x 4½
6 cyl, 108 hp @ 2400 rpm, 4 x 4¾
6 cyl, 122 hp @ 2400 rpm, 4¼ x 4¾
6 cyl, 120 hp @ 2000 rpm, 4⅜ x 5¼
6 cyl, 133 hp @ 2000 rpm, 4⅝ x 5¼
6 cyl, 146 hp @ 1200 rpm, 5½ x 6
6 cyl, 177 hp @ 1800 rpm, 5 x 6
6 cyl, 191 hp @ 1800 rpm, 5¼ x 6
6 cyl, 193 hp @ 1600 rpm, 5½ x 6

HILL DIESEL ENGINE CO

Lansing, Mich.

4-cycle vertical
2 & 4 cyl, 17–34 hp @ 1500 rpm, 3½ x 5½
6 cyl, 51 hp @ 1500 rpm, 3½ x 5½
4 & 6 cyl, 47–70 hp @ 900 rpm, 5 x 7

4-cycle V-type
8 cyl, 156 hp @ 1500 rpm, 5 x 7

HOOVEN, OWENS, RENTSCHLER DIV

General Machinery Corp, Hamilton, Ohio

2-cycle vertical
1200–12,000 hp @ 100–900 rpm
Also marine engines

INGERSOLL-RAND COMPANY

11 Broadway, New York, N. Y.

4-cycle vertical
3–8 cyl, 225–600 hp @ 720 rpm, 10½ x 12

INTERNATIONAL HARVESTER CO

180 N Michigan Ave, Chicago, Ill.

4-cycle vertical
4 cyl, 40 hp @ 1500 rpm, 3⅞ x 5¼
4 cyl, 52 hp @ 1500 rpm, 4.4 x 5.5
4 cyl, 66 hp @ 1350 rpm, 4¾ x 6½
6 cyl, 100 hp @ 1400 rpm, 4¾ x 6½

LISTER-BLACKSTONE, INC

1706 S 68th St, Milwaukee, Wis.

4-cycle vertical
1 cyl, 14 hp @ 700 rpm, 5⅞ x 7½
1 cyl, 18 hp @ 640 rpm, 6½ x 8½
1 cyl, 22 hp @ 600 rpm, 7¼ x 9½
1 cyl, 37 hp @ 500 rpm, 8¾ x 13
1 cyl, 50 hp @ 450 rpm, 10 x 14
1 cyl, 70 hp @ 420 rpm, 11¾ x 15½

4-cycle horizontal
1 & 2 cyl, 6–12 hp @ 650 rpm, 4½ x 5½
1 & 2 cyl, 8–16 hp @ 1200 rpm, 4½ x 4⅝
2–4 cyl, 21–40 hp @ 1200 rpm, 4½ x 5½

LORIMER DIESEL ENGINE CO

16th & Wood Sts, Oakland, Calif.

4-cycle vertical
2 & 4 cyl, 20– 40 hp @ 600 rpm, 5¾ x 7½
1–4 cyl, 15– 60 hp @ 600 rpm, 6½ x 8½
6 & 8 cyl, 100–135 hp @ 600 rpm, 6½ x 8½

MURPHY DIESEL COMPANY

5317 W Burnham St, Milwaukee, Wis.

4-cycle vertical
4 & 6 cyl, 105–160 hp @ 1200 rpm, 5¾ x 6½
*6 cyl, 200 hp @ 1200 rpm, 5¾ x 6½
*Supercharged

NATIONAL SUPPLY COMPANY

Superior Engine Div,
Holmesburg, Philadelphia, Pa., and Springfield, Ohio

4-cycle vertical
2 cyl, 24– 29 hp @ 1400 rpm, 4½ x 5¾
4 cyl, 48– 58 hp @ 1400 rpm, 4½ x 5¾
6 cyl, 72– 87 hp @ 1400 rpm, 4½ x 5¾
8 cyl, 98–116 hp @ 1400 rpm, 4½ x 5¾
4 cyl, 75– 90 hp @ 1200 rpm, 5½ x 7
6 cyl, 114–136 hp @ 1200 rpm, 5½ x 7
8 cyl, 152–182 hp @ 1200 rpm, 5½ x 7
3–6 cyl, 50–135 hp @ 514–720 rpm, 7 x 9
8 cyl, 135–180 hp @ 514–720 rpm, 7 x 9
5–6 cyl, 140–240 hp @ 514–720 rpm, 8½ x 10½
8 cyl, 225–320 hp @ 514–720 rpm, 8½ x 10½
3–6 cyl, 100–260 hp @ 450–600 rpm, 9 x 12
8 cyl, 270–350 hp @ 450–600 rpm, 9 x 12
5–6 cyl, 300–514 hp @ 360–514 rpm, 12 x 15
8 cyl, 480–685 hp @ 360–514 rpm, 12 x 15
4–6 cyl, 230–490 hp @ 300–400 rpm, 12½ x 16½
8 cyl, 460–650 hp @ 300–400 rpm, 12½ x 16½
5–6 cyl, 435–725 hp @ 277–360 rpm, 14½ x 20
8 cyl, 700–960 hp @ 277–360 rpm, 14½ x 20
Also marine engines

NORDBERG MANUFACTURING CO

Milwaukee, Wis.

2-cycle vertical
3– 8 cyl, 750–2000 hp @ 257 rpm, 17 x 25
5–10 cyl, 2000–4000 hp @ 225 rpm, 21½ x 29
5–10 cyl, 2150–4250 hp @ 225 rpm, 21½ x 31

POWER MANUFACTURING CO

Marion, Ohio. (No data)

RATHBUN-JONES ENGINEERING CO

Toledo, Ohio

4-cycle vertical
3–8 cyl, 175– 465 hp @ 360 rpm, 11 x 18
3–8 cyl, 260– 693 hp @ 300 rpm, 13¼ x 22
3–8 cyl, 380–1013 hp @ 277 rpm, 16 x 24
5–8 cyl, 950–1520 hp @ 240 rpm, 19½ x 28

JOSEPH REID GAS ENGINE CO

Oil City, Pa. (1939 data)

2-cycle vertical
2 cyl, 26–55 hp @ 250–550 rpm, 7½ x 9
2 cyl, 30–65 hp @ 250–550 rpm, 8¼ x 9

2-cycle horizontal
1 cyl, 14– 30 hp @ 250–550 rpm, 7½ x 9
1 cyl, 16– 35 hp @ 250–550 rpm, 8¼ x 9
1–2 cyl, 27– 93 hp @ 250–500 rpm, 9 x 12
1–2 cyl, 34–126 hp @ 250–500 rpm, 10¼ x 12
1–2 cyl, 35–132 hp @ 200–425 rpm, 10¾ x 14
1–2 cyl, 40–147 hp @ 200–425 rpm, 11½ x 14
1 cyl, 44– 81 hp @ 200–425 rpm, 12¼ x 14
1–2 cyl, 50–188 hp @ 175–375 rpm, 12½ x 16
1–2 cyl, 52–204 hp @ 175–375 rpm, 13¼ x 16
1 cyl, 72–126 hp @ 175–325 rpm, 14½ x 18
1 cyl, 78–134 hp @ 175–325 rpm, 15 x 18

R H SHEPPARD COMPANY

Hanover, Pa.

4-cycle vertical
1 cyl, 8 hp @ 1200 rpm, 4 x 5
3 cyl, 25 hp @ 1200 rpm, 4 x 5

STERLING ENGINE COMPANY

1250 Niagara St, Buffalo, N. Y. (1939 data)

2-cycle, opposed-piston engine
4 cyl*, 135–150 hp @ 1200 rpm, 4.24 x 5.45
*8 pistons (Michell patents)

STOVER MANUFACTURING & ENGINE CO

Freeport, Ill.

4-cycle vertical, single-acting
1 cyl, ¾ hp @ 2000 rpm, 2 x 17⅝
1 cyl, 1½–3 hp @ 1200–2200 rpm, 2¾ x 2¾
1 cyl, 1½–3 hp @ 1200–2200 rpm, 2½ x 2¾
1 cyl, 5 hp @ 1200 rpm, 3⅞ x 5¼
1 cyl, 7½ hp @ 1200 rpm, 4¼ x 5¼
1 cyl, 10 hp @ 1200 rpm, 5 x 6½
1 cyl, 15 hp @ 1200 rpm, 5½ x 6½

4-cycle vertical, double-acting
2 cyl, 3– 5 hp @ 1200–2200 rpm, 2½ x 2¾
2 cyl, 7–10 hp @ 1200–2200 rpm, 2⅞ x 4

4-cycle horizontal
1 cyl, 1½ hp @ 600 rpm, 3½ x 3½
1 cyl, 1½–2 hp @ 600 rpm, 3¼ x 4½
1 cyl, 2–2½ hp @ 575 rpm, 3½ x 5
1 cyl, 3–3½ hp @ 575 rpm, 4¼ x 5
1 cyl, 4–5 hp @ 550 rpm, 4¾ x 6
1 cyl, 6–8 hp @ 450 rpm, 5¾ x 8
1 cyl, 8–10 hp @ 450 rpm, 6½ x 8

THE TITUSVILLE IRON WORKS CO

Titusville, Pa.

2-cycle horizontal
1 cyl, 40 hp @ 120–350 rpm, 11 x 15
1 cyl, 50 hp @ 120–350 rpm, 12 x 15
1 cyl, 65 hp @ 120–350 rpm, 12½ x 16
1 cyl, 70 hp @ 120–350 rpm, 13¼ x 16
2 cyl, 150 hp @ 120–400 rpm, 13 x 18
2 cyl, 180 hp @ 120–400 rpm, 14 x 18
2 cyl, 210 hp @ 120–400 rpm, 16 x 18

2-cycle vertical
2 cyl, 50 hp @ 150–600 rpm, 7½ x 10
2 cyl, 60 hp @ 150–600 rpm, 8 x 10
2 cyl, 75 hp @ 150–600 rpm, 9 x 10

THE UNION DIESEL ENGINE CO

Kennedy & E 7th Sts, Oakland, Calif.

4-cycle vertical
3 & 4 cyl, 70– 95 hp @ 425 rpm, 8 x 11
3 & 4 cyl, 85–115 hp @ 350 rpm, 9 x 13
6 cyl, 180 hp @ 360 rpm, 9 x 13
3 & 4 cyl, 125–165 hp @ 290 rpm, 11 x 15
6 & 8 cyl, 275–360 hp @ 320 rpm, 11 x 15
4 cyl, 225 hp @ 270 rpm, 12½ x 17
6 & 8 cyl, 350–460 hp @ 280 rpm, 12½ x 17
6 cyl, 175 hp @ 475 rpm, 8½ x 11
6 cyl, 230 hp @ 350 rpm, 10 x 14
6 cyl, 450 hp @ 255 rpm, 14 x 19
6 & 8 cyl, 600–800 hp @ 240 rpm, 16 x 20½

UNITED STATES MOTORS CORP

Oshkosh, Wis.

4-cycle vertical
2 & 4 cyl, 14–33 hp @ 900 rpm, 3¾ x 4½
2 & 4 cyl, 21–42 hp @ 1200 rpm, 4¼ x 4½
6 cyl, 47 hp @ 1200 rpm, 3¾ x 4½
6 cyl, 59 hp @ 900 rpm, 4⅜ x 5¼
6 cyl, 80 hp @ 1200 rpm, 4⅜ x 4¼
6 cyl, 113 hp @ 900 rpm, 5½ x 6
6 cyl, 122 hp @ 1200 rpm, 5 x 6
6 cyl, 147 hp @ 1200 rpm, 5½ x 6

VENN-SEVERIN MACHINE CO

1317 W North Ave, Chicago, Ill.

2-cycle vertical
1–2 cyl, 20– 40 hp @ 650 rpm, 7 x 8
1–2 cyl, 30– 60 hp @ 400 rpm, 10½ x 12
1 cyl, 40 hp @ 300 rpm, 12¼ x 13½
1 cyl, 60 hp @ 300 rpm, 14¼ x 16½
2 cyl, 85–100 hp @ 300–327 rpm, 12¼ x 13½
3–4 cyl, 100–125 hp @ 425 rpm, 10½ x 12
2–4 cyl, 130–300 hp @ 300–327 rpm, 14¼ x 16½
3–4 cyl, 150–200 hp @ 327 rpm, 12¼ x 13½
Moderate-pressure oil engines

WASHINGTON IRON WORKS

1500 6th Ave, South, Seattle, Wash.

4-cycle vertical
3–4 cyl, 68– 90 hp @ 450 rpm, 8 x 10½
3–8 cyl, 92– 220 hp @ 514 rpm, 8 x 11
3–8 cyl, 90– 240 hp @ 400 rpm, 9 x 12½
3–8 cyl, 120– 320 hp @ 360 rpm, 10¼ x 13½
3–8 cyl, 150– 400 hp @ 327 rpm, 11½ x 15
4–8 cyl, 310– 620 hp @ 400 rpm, 12¾ x 16
6–8 cyl, 450– 600 hp @ 270 rpm, 14½ x 18
6–8 cyl, 750–1000 hp @ 327 rpm, 16 x 20
6–8 cyl, 750–1000 hp @ 225 rpm, 18 x 24
Also marine engines

WAUKESHA MOTOR CO

Waukesha, Wis.

4-cycle vertical
4 cyl, 39 hp @ 1500 rpm, 4 x 5
4 cyl, 49 hp @ 1400 rpm, 4⅝ x 5¼
6 cyl, 52 hp @ 1800 rpm, 3¾ x 4¼
6 cyl, 98 hp @ 1500 rpm, 4½ x 5½
6 cyl, 124 hp @ 1400 rpm, 5¼ x 6
6 cyl, 169 hp @ 1300 rpm, 6¼ x 6½
6 cyl, 147 hp @ 1050 rpm, 6½ x 7
6 cyl, 170 hp @ 1050 rpm, 7 x 7
6 cyl, 200 hp @ 950 rpm, 7 x 8¼
6 cyl, 282 hp @ 900 rpm, 8½ x 8½
Hesselman license

WEBER ENGINE COMPANY

Kansas City, Mo.

2-cycle horizontal
1 cyl, 25 hp @ 225 rpm, 10¼ x 14
1 cyl, 30 hp @ 225 rpm, 11 x 14
1 cyl, 35 hp @ 225 rpm, 12 x 14
1 cyl, 40 hp @ 225 rpm, 13 x 14
1 cyl, 50 hp @ 225 rpm, 14 x 14

2-cycle vertical
2–4 cyl, 50–100 hp @ 550 rpm, 7½ x 9
2–4 cyl, 60–120 hp @ 550 rpm, 8¼ x 9
All engines convertible to gas

WITTE ENGINE WORKS

1600 Oakland Ave, Kansas City, Mo.

4-cycle vertical
1 cyl, 4 hp @ 1200 rpm, 3¼ x 4½
1 cyl, 9 hp @ 1200 rpm, 4¼ x 5¼
2 & 4 cyl, 18–36 hp @ 1200 rpm, 4¼ x 5¼

4-cycle horizontal
1 cyl, 6 hp @ 850 rpm, 4¼ x 6
1 cyl, 12 hp @ 720 rpm, 5 x 8
Also marine engines

WOLVERINE MOTOR WORKS, INC

35 Union Ave, Bridgeport, Conn.

2-cycle vertical
2–4 cyl, 25– 70 hp @ 425–550 rpm, 6⅝ x 8⅝
6 cyl, 75–100 hp @ 425–550 rpm, 6⅝ x 8⅝

4-cycle vertical
2–6 cyl, 40–180 hp @ 400–600 rpm, 8 x 10½
2–4 cyl, 50–120 hp @ 360–400 rpm, 8½ x 12½
6 cyl, 150–180 hp @ 360–400 rpm, 8½ x 12½
4 cyl, 120–140 hp @ 360–400 rpm, 8¾ x 13
4–8 cyl, 140–300 hp @ 360–400 rpm, 9¼ x 14
Also marine engines

WORTHINGTON PUMP & MACHINERY CORP

Harrison, N. J.

4-cycle vertical
5– 6 cyl, 150– 180 hp @ 600 rpm, 8 x 10½
3– 8 cyl, 170– 450 hp @ 450 rpm, 10¾ x 14½
3– 8 cyl, 250– 665 hp @ 360 rpm, 13¼ x 17½
3–12 cyl, 375–1500 hp @ 327 rpm, 16 x 20
3–12 cyl, 375–1500 hp @ 225 rpm, 17 x 25

Gas-Engine Manufacturers & Suppliers

Listings are as complete and accurate as available information permits, but POWER assumes no responsibility for errors or omissions. Almost all listings supplied by manufacturers. Abbreviations are: cyl — cylinder, hp — horsepower, rpm — revolutions per minute. The two numbers at the end of each line are respectively bore and stroke in inches.

In listing the number of cylinders, the hyphen (5-8) means that intermediate numbers of cylinders give intermediate horsepower in even steps; the "and" sign (6 & 8) means that only the two sizes are available.

ATLAS-IMPERIAL DIESEL ENGINE CO
Oakland, Calif.

4-cycle vertical
2-4 cyl, 35- 75 hp @ 720 rpm, 6½ x 8½
6 cyl, 110 hp @ 720 rpm, 6½ x 8½
3 & 4 cyl, 65- 85 hp @ 514 rpm, 7½ x 10½
3 & 4 cyl, 75-100 hp @ 514 rpm, 8 x 10½
4-6 cyl, 120-185 hp @ 514 rpm, 9 x 10½
8 cyl, 250 hp @ 514 rpm, 9 x 10½

THE BRUCE-MACBETH ENGINE CO
2111 Center St, N W, Cleveland, Ohio

4-cycle vertical
3-6 cyl, 90-180 hp @ 514 rpm, 9 x 10½
2 cyl, 40- 45 hp @ 400-450 rpm, 8½ x 9
2 cyl, 55- 60 hp @ 327-360 rpm, 10 x 12
2 cyl, 65- 70 hp @ 327-360 rpm, 11 x 12
2 cyl, 80- 90 hp @ 277-300 rpm, 12¼ x 15
2 cyl, 90-100 hp @ 277-300 rpm, 13½ x 15
4 cyl, 110-120 hp @ 327-360 rpm, 10 x 12
4 cyl, 130-145 hp @ 327-360 rpm, 11 x 12
4 cyl, 170-185 hp @ 277-300 rpm, 12¼ x 15
4 cyl, 210-225 hp @ 277-300 rpm, 13½ x 15
4 cyl, 250-270 hp @ 257-277 rpm, 14½ x 17
4 cyl, 325-350 hp @ 257-277 rpm, 16½ x 17
4 cyl, 425-450 hp @ 225-240 rpm, 18½ x 20

CATERPILLAR TRACTOR CO
Peoria, Ill.

4-cycle vertical
4 cyl, 20- 34 hp @ 800-1600 rpm, 3¾ x 5
4 & 6 cyl, 28- 75 hp @ 800-1600 rpm, 4¼ x 5½
6 & 8 cyl, 84-180 hp @ 550-1000 rpm, 5¾ x 8*
*Convertible to diesel operation

CLARK BROTHERS COMPANY
Olean, N. Y.

2-cycle vertical
2 cyl, 25-30 hp @ 600 rpm, 5¾ x 7
2 cyl, 40-50 hp @ 400 rpm, 7½-8½ x 9
2-6 cyl, 200- 750 hp @ 300-330 rpm, 14 x 14
8 cyl, 800-1000 hp @ 330-330 rpm, 14 x 14

4-cycle vertical
3 & 4 cyl, 150-240 hp @ 600-720 rpm, 10 x 12
6 & 8 cyl, 300-480 hp @ 600-720 rpm, 10 x 12
3 & 4 cyl, 185-300 hp @ 600-720 rpm, 11½ x 12
6 & 8 cyl, 375-600 hp @ 600-720 rpm, 11½ x 12
Also angle gas-engine-compressor units and convertible pumping engines

THE COOPER-BESSEMER CORP
Mt Vernon, Ohio

2-cycle horizontal, single-acting
1-2 cyl, 30-150 hp @ 180-325 rpm
1 cyl, 40- 70 hp @ 180-300 rpm, 12½ x 16
1 cyl, 50- 80 hp @ 180-300 rpm, 13½ x 16
1-2 cyl, 125-250 hp @ 200 rpm, 17 x 20

4-cycle horizontal, double-acting
1-2 cyl, 400- 800 hp @ 180 rpm, 19 x 24
1-2 cyl, 500-1000 hp @ 125 rpm, 21½ x 36
1-2 cyl, 750-1500 hp @ 125 rpm, 26 x 36

2-cycle vertical
2 cyl, 25-35 hp @ 600-800 rpm, 5½ x 7
2 cyl, 40-60 hp @ 400-600 rpm, 7½ x 9

4-cycle vertical
3, 4, 6, 8 cyl, 65- 480 hp @ 400-900 rpm, 9 x 10½
3, 4, 6, 8 cyl, 125- 800 hp @ 360-750 rpm, 11½ x 13½
3, 4, 6, 8 cyl, 275- 875 hp @ 325-514 rpm, 13 x 16
6, 7, 8 cyl, 450-1250 hp @ 225-350 rpm, 15½ x 22

ENTERPRISE ENGINE CO
San Francisco, Calif. (No data)

FULTON IRON WORKS CO
St. Louis, Mo.

4-cycle vertical
3-8 cyl, 225- 600 hp @ 277 rpm, 15 x 18
4-8 cyl, 500-1000 hp @ 225 rpm, 18 x 24½

INGERSOLL-RAND COMPANY
11 Broadway, New York, N. Y.

4-cycle vertical
4 & 6 cyl, 185-275 hp @ 400 rpm, 11 x 13½
8 cyl, 370 hp @ 400 rpm, 11 x 13½
6 & 8 cyl, 485-650 hp @ 300 rpm, 14½ x 18
Also angle gas-engine-compressor units

LE ROI COMPANY
Milwaukee, Wis.

4-cycle vertical
4 cyl, 27 hp @ 1200 rpm, 3¾ x 4
4 cyl, 32 hp @ 1200 rpm, 4 x 4
4 cyl, 43 hp @ 1200 rpm, 4 x 4½
4 cyl, 46 hp @ 1200 rpm, 4½ x 5
4 cyl, 57 hp @ 1200 rpm, 4½ x 6
4 cyl, 70 hp @ 1200 rpm, 5 x 6
4 & 6 cyl, 64- 96 hp @ 900 rpm, 5 x 7
4 & 6 cyl, 77-116 hp @ 900 rpm, 5½ x 7
4 & 6 cyl, 92-137 hp @ 900 rpm, 6 x 7
4 & 6 cyl, 99-148 hp @ 900 rpm, 6¼ x 7
4 & 6 cyl, 116-174 hp @ 900 rpm, 6¾ x 7
8 & 12 cyl, 198-295 hp @ 900 rpm, 6¼ x 7
8 & 12 cyl, 232-346 hp @ 900 rpm, 6¾ x 7

NATIONAL SUPPLY COMPANY
Superior Engine Div, Springfield, Ohio

NATIONAL TRANSIT PUMP & MACHINE CO
Oil City, Pa.

4-cycle vertical
2-4 cyl, 27- 54 hp @ 600 rpm, 6 x 9
6 & 8 cyl, 80-108 hp @ 600 rpm, 6 x 9

4-cycle horizontal, single-acting
1 & 2 cyl, 85-170 hp @ 180 rpm, 17 x 24

4-cycle horizontal, double-acting
2 & 4 cyl, 310- 620 hp @ 180 rpm, 17 x 24
2 & 4 cyl, 400- 800 hp @ 165 rpm, 19 x 27
2 & 4 cyl, 500-1000 hp @ 150 rpm, 21 x 30
2 & 4 cyl, 600-1200 hp @ 125 rpm, 23 x 36
2 & 4 cyl, 750-1500 hp @ 125 rpm, 26 x 36

RATHBUN-JONES ENGINEERING CO
Toledo, Ohio

4-cycle vertical
3-8 cyl, 225- 600 hp @ 360 rpm, 12¾ x 18
3-8 cyl, 355- 950 hp @ 300 rpm, 15½ x 22
3-8 cyl, 507-1350 hp @ 277 rpm, 18½ x 24
5-8 cyl, 1340-2140 hp @ 240 rpm, 23 x 28

STERLING ENGINE COMPANY
1250 Niagara St, Buffalo, N. Y. (1939 data)

4-cycle vertical
6 cyl, 170 hp @ 1200 rpm, 5¾ x 6¾
8 cyl, 230 hp @ 1200 rpm, 5¾ x 6¾
6 cyl, 50-100 hp @ 1200 rpm, 5¼ x 6
6 cyl, 225-300 hp @ 900 rpm, 8 x 9
8 cyl, 325-400 hp @ 900 rpm, 8 x 9

THE TITUSVILLE IRON WORKS CO
Titusville, Pa.

2-cycle horizontal
1 cyl, 40- 45 hp @ 120-300 rpm, 11 x 15
1 cyl, 45- 55 hp @ 120-350 rpm, 12 x 15
2 cyl, 125 hp @ 120-350 rpm, 12 x 15
1 cyl, 65 hp @ 120-350 rpm, 12½ x 16
1-2 cyl, 55-150 hp @ 120-400 rpm, 13 x 18
1-2 cyl, 60-180 hp @ 120-400 rpm, 14 x 18
1 cyl, 70 hp @ 120-350 rpm, 13¼ x 16
2 cyl, 210 hp @ 120-400 rpm, 16 x 18

2-cycle vertical
2 cyl, 50 hp @ 150-600 rpm, 7½ x 10
2 cyl, 60 hp @ 150-600 rpm, 8 x 10
2 cyl, 75 hp @ 150-600 rpm, 9 x 10

WAUKESHA MOTOR CO
Waukesha, Wis.

4-cycle vertical
4 cyl, 14 hp @ 2000 rpm, 2½ x 3¼
4 cyl, 25½ hp @ 1800 rpm, 3¼ x 4
4 cyl, 33 hp @ 1800 rpm, 3⅝ x 4½
4 cyl, 41 hp @ 1500 rpm, 4 x 5
4 cyl, 50 hp @ 1400 rpm, 4½ x 5¼
4 cyl, 56 hp @ 1400 rpm, 4⅝ x 5¼
4 cyl, 67½ hp @ 1050 rpm, 5⅛ x 6¼
6 cyl, 59 hp @ 2000 rpm, 3¾ x 4¼
6 cyl, 65 hp @ 2000 rpm, 4 x 4¼
6 cyl, 66 hp @ 1600 rpm, 4¼ x 4¾
6 cyl, 82 hp @ 1500 rpm, 4⅝ x 5⅛
6 cyl, 104 hp @ 1500 rpm, 4½ x 5½
6 cyl, 136 hp @ 1400 rpm, 5¼ x 6
6 cyl, 136 hp @ 1400 rpm, 5½ x 5½
6 cyl, 193 hp @ 1300 rpm, 6¼ x 6½
6 cyl, 173 hp @ 1050 rpm, 6½ x 7
6 cyl, 195 hp @ 1050 rpm, 7 x 7
6 cyl, 213 hp @ 950 rpm, 7 x 8½
6 cyl, 374 hp @ 900 rpm, 8½ x 8½

WEBER ENGINE COMPANY
Kansas City, Mo.

2-cycle vertical
1 cyl, 25 hp @ 550 rpm, 7½ x 9
1 cyl, 30 hp @ 550 rpm, 8¼ x 9
1-2 cyl, 10-20 hp @ 700 rpm, 4⅞ x 6½

WITTE ENGINE WORKS
1600 Oakland Ave, Kansas City, Mo.

4-cycle vertical
1 cyl, 4 hp @ 1200 rpm, 3¼ x 4½
1 cyl, 9 hp @ 1200 rpm, 4¼ x 5¼

WORTHINGTON PUMP & MACHINERY CORP
Harrison, N. J.

4-cycle vertical
5- 6 cyl, 175- 210 hp @ 600 rpm, 9 x 10½
3- 8 cyl, 200- 535 hp @ 450 rpm, 12¼ x 14½
3- 8 cyl, 300- 800 hp @ 360 rpm, 15 x 17½
3-12 cyl, 345-1380 hp @ 327 rpm, 16 x 20
3-12 cyl, 375-1500 hp @ 225 rpm, 18 x 25
3-12 cyl, 450-1800 hp @ 225 rpm, 20 x 25
3-16 cyl, 540-2880 hp @ 257 rpm, 20 x 25
Also angle gas-engine-compressor units

A DEFENSE DIGEST

Trends, troubles, achievements, shortcomings, gossip and sidelights of the National Defense Program, with particular reference to industry's job of production, in which the power engineer is a key man

Coal is as important as powder in modern war. The public had nearly learned this great truth when the coal strike was settled late in April. A critical shortage of steam coal in many industries was barely avoided. Real damage was done to steel production through the shutting down of blast furnaces and coke ovens. Production thus missed is lost forever and defense is set back. Who's to blame?

The average business man doesn't understand how coal fits into the industrial picture, as you are probably well aware. POWER editors asked a number of executives what coal is used for in industry. Nobody mentioned process steam—the most important use.

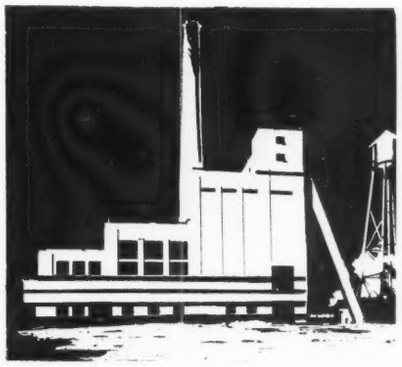
American productive genius is being asked to perform miracles. On April 14, John D Biggers, Director of the Production Division, OPM, said that the start of *real* mass production in defense was due by August 1, one hundred days away, and he asked that this be chopped to ninety. So it's "shoot the works"—for it isn't inconceivable that ten days lopped off this hundred might change the whole course of the war.

The aviation industry is a smashing example of such miracles. The magicians heading the aircraft companies have been given three years to build

up a 4-billion-dollar industry—to do what took the automobile manufacturers 30 years.

Aviation's backlog is now $4,000,000,000—four thousand million dollars of unfilled orders—about $30 worth for every man, woman and child in the U. S. To put it another way, the average family of five has on order $150 worth of war planes, but doesn't know it. Small wonder the government is thinking about new taxes.

Machine tools are still another miracle, jumping from $400,000,000 production in 1940 to $750,000,000 scheduled for this year and shooting for a billion dollars in 1942. No industry is working its machines more days a week (7 is the limit under present regulations) or more hours per day. Some 65,000 machine tools are now on order for defense purposes, and the order backlog is nearly $600,000,000.



Is industry doing a good defense job? You read a lot of contradictory opinions in the newspapers, but the fact is that steel, aircraft, machine tools, and other lines directly in defense, have made quite a showing, all things considered. The main trouble lies in hundreds of small and medium-sized plants, mostly metal working, that are doing no defense work.

With subcontracting made easy through the local Federal Reserve offices, all of these plants should be able to put their idle machine-tool hours to productive use. These idle tools in small plants seem to reflect a general failure to appreciate the gravity of the defense situation. By the way, a machine working an 8-hour shift each day for five or six days, and then just sitting, must be classified as two-thirds idle.

A shortage of supervisors seems to be in the cards for many lines of defense work. This lack may be more serious than that of skilled mechanics. Ways have been found to "dilute" the work of each skilled mechanic with that of several semi-skilled and unskilled men, but there has to be someone to boss the job, to plan and follow the work. That means supervisors, and there aren't enough of them, so management is paying more attention to training suitable men.

It takes longer to get a big steam turbine than it used to, but not as much longer as some rumors would suggest. For example, a recent turbine order for two large units of new design is expected to be completed in 24 months or less, compared to a normal 18 months. Boiler plant, customarily ordered several months after placement of the turbine contract, can now be scheduled for completion at the same time as the turbine if orders are placed within a month of each other. The pinch has been felt most in units of smaller size and more standard designs.

As for power-plant auxiliaries, there is a definite tendency by manufacturers to concentrate on standard lines, letting someone else worry about the special stuff that takes time and experimenting.

Significant is the fact that all new utility plants and additions planned for operation this spring have been on schedule—which has never happened before in the history of the power business. And there seems to be no reason why this heartening condition shouldn't continue for another four or five months. Beyond that, it's impossible to predict much of anything these days.

Since making this initial Riley Installation Curtiss-Wright Corporation have ordered 15 additional Riley Boiler Units

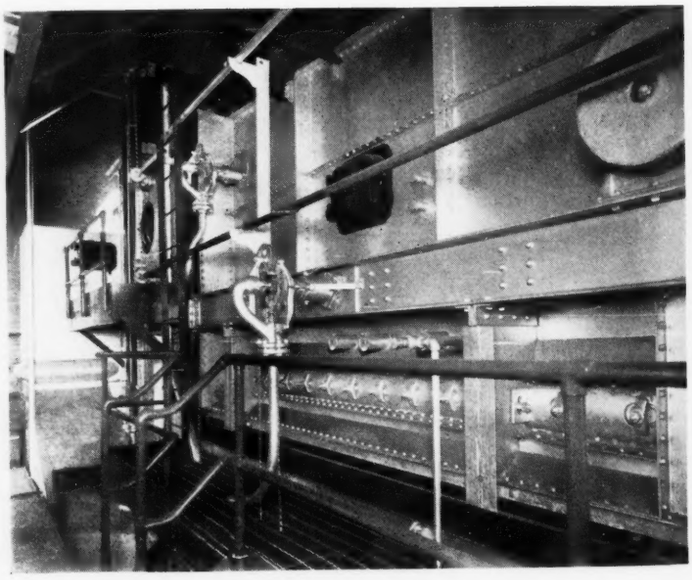
RILEY BOILER UNIT REDUCES STEAM

The Curtiss-Wright boiler plant at Buffalo, N. Y., consisted of three 400 H. P. straight tube boilers fired by traveling grate stokers with space allowed for an additional unit. Rapid expansion of the aeroplane industry in recent years increased steam demand beyond the capacity of the existing plant.

A thorough investigation indicated the advisability of installing a modern high efficiency unit rather than merely installing a duplicate of the existing units.

A Riley Boiler Unit fired by Riley Pulverizers and Burners was ordered October 11, 1939. The unit went on the line February 1, 1940, and has been carrying the plant load since that time with complete satisfaction. Efficiencies of 86.2% are being obtained. Results indicate fuel savings in excess of $10,000 per year. Another well-known company has become a Riley booster.

Engineers are invariably impressed with the ease with which new Riley Boiler Units are placed on the line and by the absence of even starting up difficulties. Efficiencies and capacities in excess of guarantees is the general rule with Riley Units. User enthusiasm is definite evidence that Riley gives you your money's worth.



View of casing seals at upper water wall header. Attention to detail of casing construction assures air tightness.

TRADE MARK Rx REGISTERED

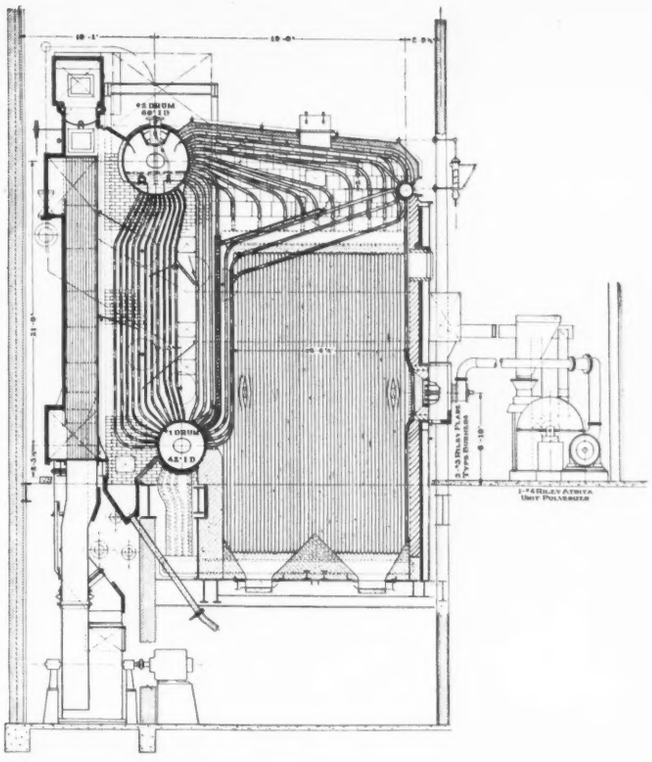
RILEY

STOKER CORPORATION, WORCESTER, MASS.

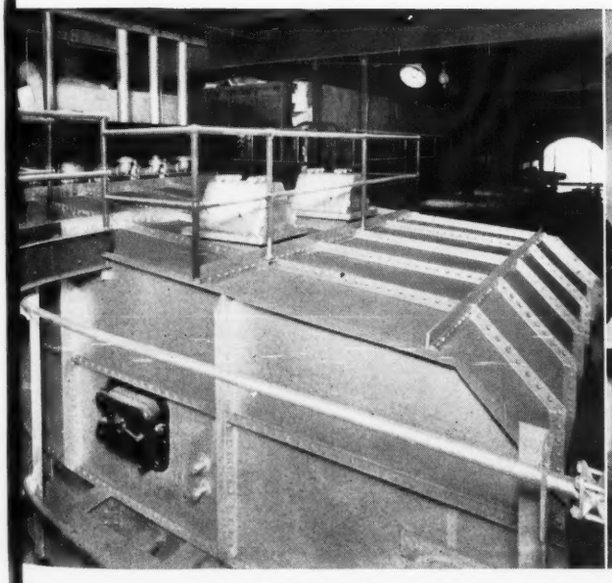
Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Seattle Baltimore Richmond Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

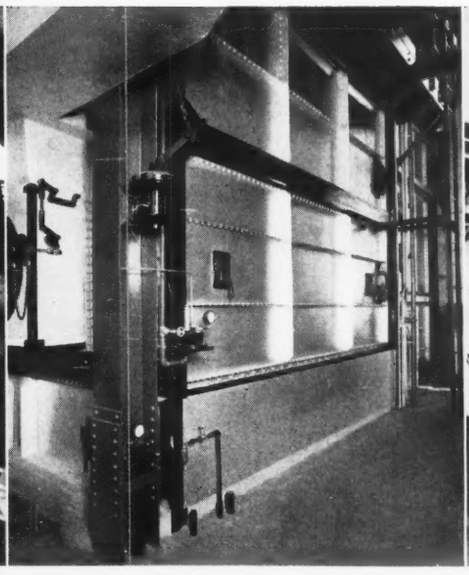
Riley Boiler Unit of Curtiss-Wright Aeroplane Corp., Buffalo, N. Y.
70,000 lbs. of steam per hour.
86.2% efficiency at 50,000 lbs./hr.
Unit consists of Riley Boiler, Water-cooled Furnace, Steel-Clad Insulated Setting, Air Heater, Riley Pulverizer and Burners.



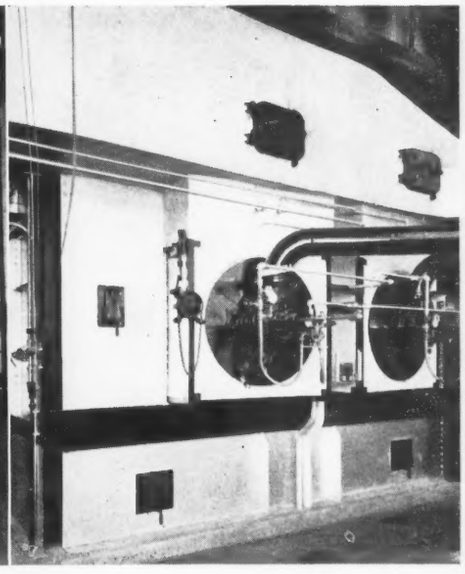
COST FOR CURTISS-WRIGHT



Casing construction over boiler roof. The cost of a flanged casing rather than batten strips is greater but positive tightness is assured.



View of side of unit. CO_2 reduction between furnace and air heater outlet with Riley units is less than ½ of 1%. Evidence of the worth of the Riley flanged casing construction.



Front of Riley unit at Curtiss-Wright Combination oil and pulverized coal Riley burners are used.

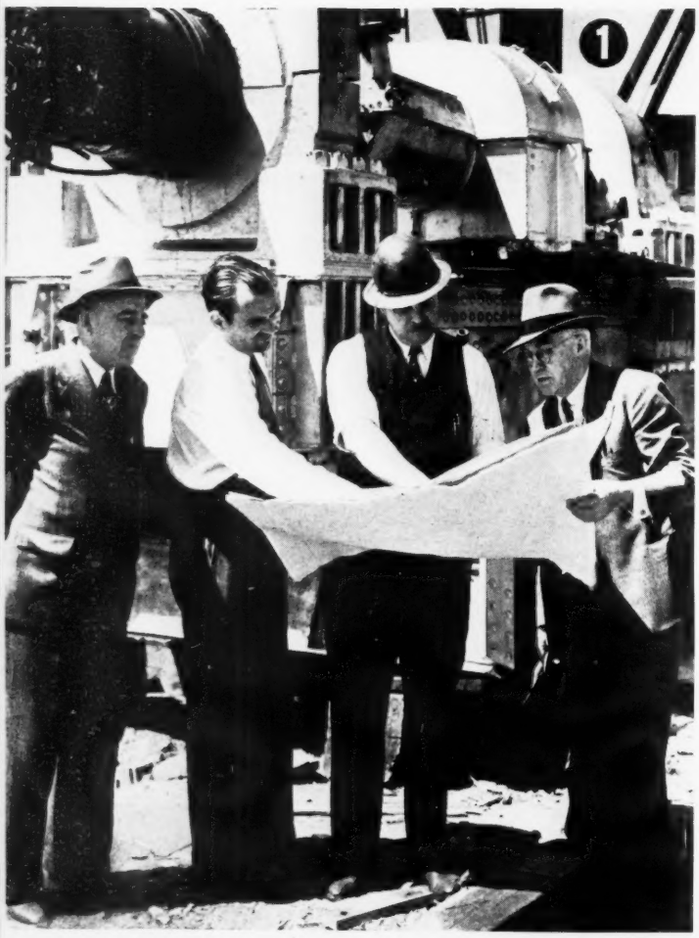
A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

Hoisting the Pintle Girder Atop Grandpa's Knob

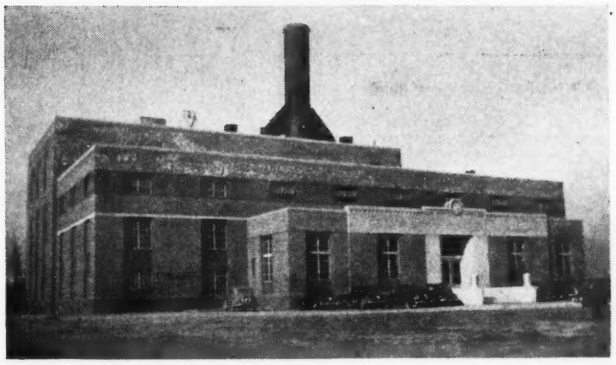


On April 26, the pintle girder for S Morgan Smith Co's aeroelectric plant on Grandpa's Knob, a 2000-ft mountain in central Vermont, was successfully hoisted into place. The entire wind-power plant will be supported on this girder, which can swing through 360 deg to keep the turbine always downwind. For complete story on this project, see page 56

1—Looking over some of the fine points of hoisting the pintle girder into place are (left to right): W Belding, superintendent of power, Central Vermont Public Service Corp; Palmer Cosslett Putnam, inventor of the wind-turbine plant; Stanton D Dornbrier, erection engineer, S Morgan Smith Co; and F A Annett, associate editor, POWER

2—Up she goes. The pintle girder, weighing nearly 50 tons, is hoisted to the top of the 110-ft structural-steel tower

3—Here the girder is being lowered into place onto the top end of the pintle shaft supported in the tower by two heavy roller bearings. The heavy timber strut jutting out from the left-hand side of the tower will support temporarily the free end of the pintle girder during erection of the power plant. In the left background can be seen the 180-ft high anemometer tower equipped with 19 instruments that are self-recording in a wind-research laboratory near the foot of the tower. Some of these anemometers are gas-heated so that a record of the wind can be obtained in even the severest ice storms



Owensboro Municipal—Designed for $1 Coal

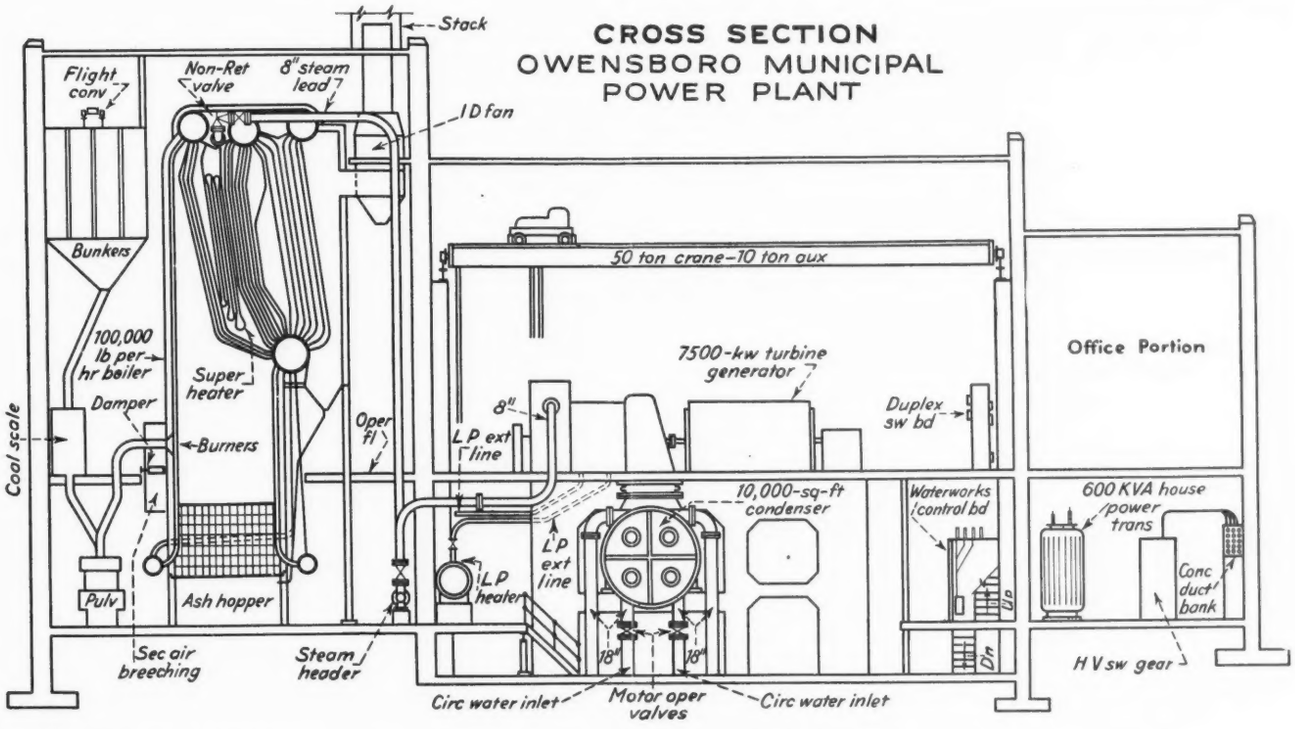
The new water and light plant for Owensboro, Ky., is saving the 30,000 citizens about $75,000 a year in operating costs, according to preliminary figures for the first six months. Previously, the city's two utilities were separately housed, but a survey showed that a considerable saving could be made by combining them under one roof.

Construction of the new plant was launched in the summer of 1938 and finished in September, 1940. The main building, which includes complete boiler and turbine rooms, electrical-switchgear room, water-filter plant and high-service pump room, is of brick and concrete with tile finish on interior walls in the boiler and turbine rooms. Floors in the turbine room and waterworks portion are topped with quarry tile, the rest are of finished concrete.

Location of the plant, 600 ft from the Ohio River, required flood protection to safeguard against high water such as occurred during 1937. All foundations were made to withstand high hydrostatic pressures.

Here is a combination power plant and water-treating station built specifically to operate on low-cost, low-grade coal. Of course, there aren't many frills, but when you can save $36,000 a year on your fuel bill, you welcome simplicity

By R C OLIVER, JR
Black & Veatch, Consulting Engineers



Two B & W, 100,000-lb-per-hr boilers, with suspended settings and water-cooled walls, produce steam at 450 lb and 750 F. Each boiler has two combination pulverized-coal and oil burners. Each burner is fed directly by an individual unit pulverizer of 8000-lb-of-coal-per-hr capacity. With present normal plant loads only a single burner per boiler is used. Each pulverizer is driven by a constant-speed motor and has a separate motor-driven feeder.

Two 5000-gal fuel-oil storage tanks, outside the plant underground, are provided with heating coils. Plans are that these two tanks will form an integral part of a large main storage system to be installed as required. At present, oil is used only to light off the pulverized coal and in emergency.

Slack coal is delivered to the plant from local mines by trucks and dumped into an outside hopper. A single-roll crusher, alongside the hopper, reduces

any large lumps. Arrangement has been made for delivery of coal by railroad if it proves more economical in the future.

A skip hoist transfers the coal to inside steel concrete-lined bunkers which in turn feed by gravity to continuous automatic scales, from which the coal is delivered directly to the pulverizers. Space has been reserved behind the plant for outside coal storage in case this proves necessary.

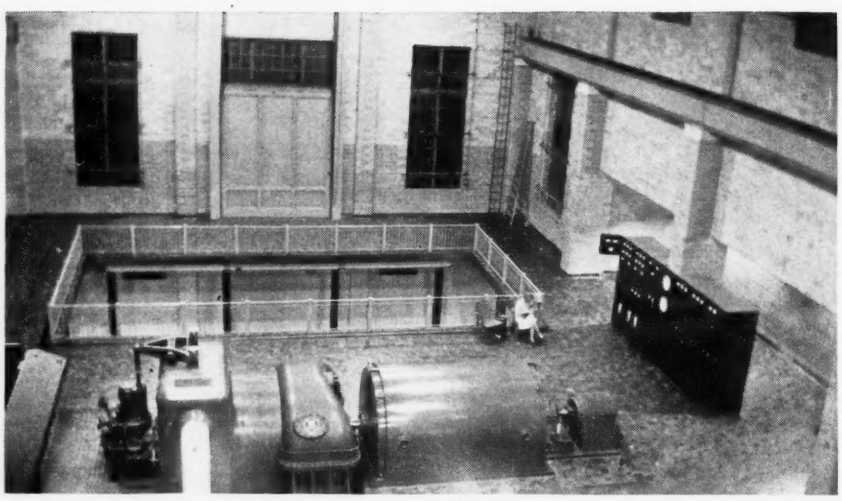
Boiler ash hoppers are dry type and ash is handled hydraulically by sluicing nozzles in the pits and a discharge pump which transfers the ash through an underground pipeline to a point about 600 ft from the plant.

Combustion control is completely automatic. All indicating and controlling instruments, as well as flowmeters, etc, are mounted on a common panel on the main firing aisle. Individual forced- and induced-draft fans on each boiler have breeching cross-connections and manually operated shut-off dampers, so that fans can be used on opposite boilers. Forced-draft units, driven by constant-speed induction motors, have inlet vane control; the induced-draft fans have combination damper and motor speed control. The induced-draft fans are powered by wound-rotor motors capable of handling all loads for the near future; however, provision has been made by shaft extension for the installation of additional large motors in the future to handle maximum boiler loads.

Electrical output of the plant is handled by a 13-section, vertical-lift switchgear. All the main-generator and high-voltage feeder breakers are included in this structure. The main switchgear, generator-field breakers, the plant auxiliary switchboard and wet batteries are in a separate fireproof room to promote better maintenance and plant safety.

Auxiliary power is supplied by either of two 600-kva, 4160/440-volt transformers, the output of which is controlled through the plant auxiliary board by air circuit breakers, which supply 440 volts through busways to two main distribution panels.

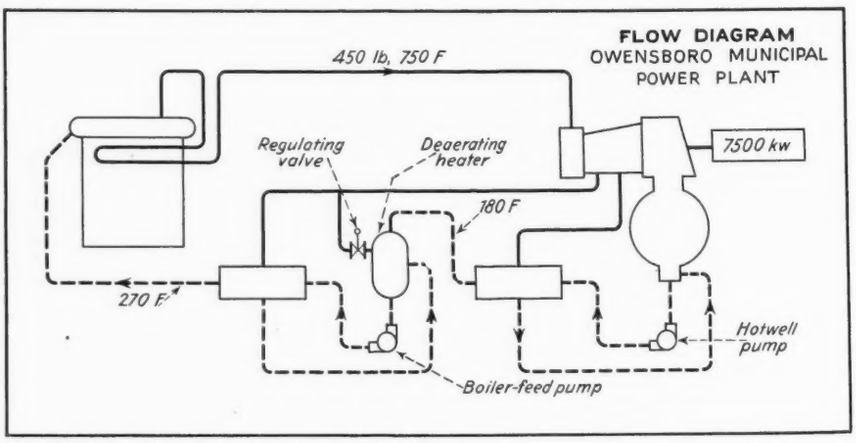
A problem created by installation of the new plant was the changeover to 3-phase current from the 2-phase energy of the old plant now abandoned. Approximately 950 motors in Owensboro belonging to various industries had to be rewound or reconnected and many changes were made in the distribution system. This program required considerable planning to avoid interference or delay in production.



Two 7500-kw turbines are supplied from individual 8-in. steam leads connected to two short headers in the boiler-room basement, so arranged and connected by an expansion loop that either boiler can be used with either turbine. Each machine drives a 3600-rpm generator producing 60-cycle current at 4160 volts. Present peak load is around 5600 kw, which allows considerable capacity for load growth. Provision has been made in the turbine room for a future third unit.

The turbines exhaust into 10,000-sq-ft surface condensers cooled with water from the Ohio River. Both condensers have duplicate electric-motor-driven condensate pumps, either of which can handle the full throttle flow at full load on the unit. The circulating-water discharge from the condensers is arranged so that a constant siphon effect is established, thus reducing the total head against which the circulating pumps have to operate. A separate intake structure in the Ohio River houses three circulating-water pumps, of 4000, 6000 and 10,000 gpm.

Water passing to the pump suctions is cleaned by a traveling screen (there is provision for future installation of a duplicate screen). Circulating water reaches the plant through a 24-in. cast-iron pipeline approximately 600-ft long which discharges into a 36-in. main header. Future plans call for a duplicate 24-in. line from the river intake to the plant, thus establishing a loop header system for circulating water to handle future plant growth properly.



The flow diagram shows the feedwater-heating cycle, which contains three heaters. The low-pressure heater is connected to No. 3 low-pressure turbine bleed point; the deaerating and high-pressure heaters obtain steam from the higher-pressure No. 2 bleed point. The other two bleed points on the turbines are blanked. At present loads, an outlet temperature of approximately 180 F is obtained at the low-pressure heater outlet and 270 F at the high-pressure outlet. These temperatures vary, of course, according to the amount of extraction steam available, which in turn depends on turbine-generator load.

Two of the three boiler-feed pumps are motor-driven (one is 100 gpm, the other 200); the third, 200 gpm, is turbine-driven. All feed the boilers through a loop system.

Both feedwater and city water are tested in the plant laboratory, which also includes equipment for running moisture tests and proximate analysis of coal. Condensate is stored in lower tanks in the boiler-room basement and transferred automatically when needed to an upper surge tank by duplicate pumps, then enters the deaerating heater. Boiler makeup is introduced into the lower tank after passing through a zeolite softener. The fact that the waterworks incorporates a complete cold-lime softening process which reduces the total hardness of raw water to approximately 6 gr per gal simplifies the feedwater problem somewhat.

A small tank for supplying condensate to the turbine-shaft sealing gland is on the upper surge-tank platform. The majority of this water is returned to the condenser hotwell after passing through the glands. A small chemical-treating tank, also on the upper surge-tank level, feeds directly as needed into the boiler-feed-pump suction line through a solenoid-controlled valve operated periodically by an electric time-clock switch.

Boiler water is maintained in proper condition by variation of the chemical feed and also of the amount of continuous blowdown from the steam-generating units.

The waterworks part of the program was for the most part an improvement of existing facilities, except for installation of new recarbonation and filtration equipment. Previously, calcium carbonate, precipitated in the distribution mains, built up over a period of years causing excessive pressure drop and high pumping costs. Now, water passing to the high-service pumps can be treated with carbon dioxide to put this precipitate gradually back into solution. However, since this is necessarily a very slow process it will be several years before any definite results from this treatment are realized.

Six months' operating results reveal very satisfactory savings. Local Daviess County, Ky., coal is burned, obtained from 10 or 12 mines in the vicinity. Tests of this coal indicate an average heat value of 10,000 Btu per lb on an as-received basis. There is considerable variation in moisture content, running from an average of 10 to 12% to a peak of approximately 20%.

Based on the above heating value, the plant has averaged less than 1.70 lb of coal per kwhr generated or approximately 16,500 Btu per kwhr. This coal has been available for $1.00 a ton delivered, and naturally was a deciding factor in the decision not to use heat-reclaiming equipment on the boilers.

Total yearly coal savings, based on operation to date, are expected to exceed $36,000 per year. Total annual savings for both the light and water departments, based on advance figures, would indicate that this figure will exceed $75,000. However, it is possible that this will be even greater because of better voltage conditions over the system and a reduction in electrical-distribution line losses.

Principal Power Equipment—Owensboro, Ky., Municipal Plant

BLACK & VEATCH, CONSULTING ENGINEERS

Steam-Generating Equipment:

Boilers, 2, 100,000 lb per hr each, 450 lb per sq in., 750 F total temperature	Babcock & Wilcox Co
Forced-draft fans	Buffalo Forge Co
Induced-draft fans	Prat-Daniel Corp
Feedwater regulator, air operated	Bailey Meter Co
Pulverizers, 4, 8000 lb coal per hr each	Babcock & Wilcox Co
Boiler instruments and controls	Bailey Meter Co
Coal scales, 2, automatic	Richardson Scale Co
Coal-handling equipment	Fairfield Engineering Co
Ash-handling equipment	Hydro-Ash Corp
Soot blowers	Diamond Power Specialty Corp

Power-Generating Equipment:

Turbine-generators, 2, 9375 kva, 2400/4160 volt, 3-phase, 80% pf, 3600 rpm	Westinghouse Elec & Mfg Co
Condensers, 10,000-sq-ft surface type	Ross Heater Co; Condenser Service & Engrg Co
Air ejectors	Ross Heater Co; Condenser Service & Engrg Co
High-pressure heater	Ross Heater Co
Low-pressure heaters, 2	Ross Heater Co; Patterson-Kelley Co
Deaerating heater	Elliott Co

Pumps, Piping and Valves:

Boiler-feed pumps, 3, 1, 200 gpm, 3550 rpm, 1443 ft head, driven by De Laval steam turbine, 106 hp, 430 lb per sq in., 750 F, 3550 rpm; 1, 200 gpm, 1443 ft head, motor driven; 1, 100 gpm, 1443 ft head, motor driven.	De Laval Steam Turbine Co
Circulating-water pumps	Dayton-Dowd Co
Power piping	J F Pritchard Co
High-pressure steel valves	Walworth Co

Electrical Equipment:

Wiring	Dearborn Electrical Const Co
Switchgear and high-voltage equipment	Westinghouse Elec & Mfg Co

Miscellaneous Equipment:

Air compressors	Worthington Pump & Mach Co; Gardner-Denver Co
High-service water pumps	Dayton-Dowd Co

Wanted — Inventions for Defense

By E S SMITH

Patent Agent, C J Tagliabue Mfg Co, Brooklyn, N.Y.

The National Inventors Council will consider your invention from the angle of national defense, but not from the angle of payment or protection. Author Smith gives useful hints for the engineer who has a practical idea for the Army, Navy or air forces and also shows how to go about getting adequate protection for the idea

▶ IF YOU HAVE AN IDEA or an invention that may be of value to national defense, the Government invites you to send it to the National Inventors Council, Commerce Building, Washington, D. C., with the assurance it will receive the consideration it merits and be handled confidentially.

The NIC cooperates closely with the Patent Office and includes scientifically-trained men whose judgment and discretion can be relied upon. It has been set up especially to give your idea more consideration than it would likely get if you sent it to your Congressman or directly to the Army or Navy.

This Council acts as a clearing house for defense ideas and inventions, carefully considers all ideas, and passes along the more promising (with recommendations) to the arm of service most likely to find them of value.

In addition to ideas of direct interest to the Army or Navy, the NIC will consider aviation inventions as well if they have potential value in defense. Aviation inventions *not* directly related to defense should be sent to the National Advisory Committee for Aeronautics, 3841 Navy Building, Washington, D. C.

Ideas not fully worked out would get little attention these days if submitted directly to the very busy Army and Navy officials. Even in normal times, they prefer to have the ideas developed by a supplying concern which can submit a full-fledged working device for their approval.

How About Pay?

Recompense is outside the sphere of the NIC, and is taken care of by the Department receiving the idea or invention. Legislation has established the legal basis (either purchase or licensing) for payment of money for inventions by the Department concerned, but there are certain rules that must be observed.

First, the idea must be protected by one or more claims in either a pending patent application or an issued patent. If you are asked to keep your idea secret for defense reasons, and do so, you will be able to seek a return for any losses caused by this secrecy, including any delay in the issuance of the patent on this account. To recover, however, you must first have offered your idea to the Department. In any case, the amount of compensation and the details thereof are reached by direct agreement between the inventor and the Department.

In the old days, you had to sue to recover anything, but recent legislation has made it possible for the Department concerned, without thought of suit, to reach agreements with inventors who have patent protection. You can still sue if no arrangement can be worked out, but litigation is almost certain to be expensive and likely to last for years if an inventor sues the government.

You Deserve a Return

Of course, as long as your invention can help America's defense, it is welcome regardless of whether it is offered freely or whether patent protection is sought as a basis for later recompense. The idea that inventions are accidents or "something for nothing" leads some to the notion that it is unpatriotic not to contribute freely to your country any invention that can possibly be used for defense. This is unfair. The man who has puzzled and studied for years to make a valuable invention should not be criticized for seeking a fair return in these days in which the defense pro-

gram is carried on without losses to either labor or to industrial capital.

If your time is at all valuable, you may arrange with your local patent agent or attorney for his Washington associate to make a "preliminary-state-of-the-art-search" at a cost of $10 or less for any simple idea or single field. This will reveal the most pertinent patents and be of great value to you, even though a few of the very latest models may be kept secret if they relate to highly confidential defense matters.

You can buy copies of the patents turned up for only ten cents a copy if you order them directly from the Patent Office, Washington, D. C. An efficient search can be made only in the search room of the Patent Office, which contains all of the U. S. Patents and most of the foreign all conveniently arranged by classes. This search room is open to the public.

Many inventors like to have their names associated with their contributions and accordingly file patent applications assigned to the free use of the United States and its citizens. Otherwise, the source of the idea is lost (as regards recognition by others) when it is submitted to the NIC.

The NIC does not furnish you with any information that will help you to decide whether or not to file a patent application. Your idea may go into public use after it has been submitted to the NIC, and you have one year from the date of such use within which to file a patent application.

Information Bulletin

If you wish to submit an idea to the NIC, by all means obtain a copy of its "Information Bulletin No. 1." You will note there that the idea should *not* be presented by a model, but that the invention must be submitted in writing in English, along with a sketch. Both should be sufficiently detailed to amount to a "constructive reduction to practice" of the idea. This last means that objects and methods or means must be definitely and clearly stated. These requirements are much the same as those for a patent specification except that, among other differences, the specification also includes definite claims for what is novel in the invention.

If you are not familiar with patent specifications, it would pay you to obtain a ten cent copy of a patent in the same general field. This will serve as a rough model. If your invention is complicated, it might be worth while to ask some friendly patent attorney or agent to look over your material. He can suggest efficient ways to picture and describe your ideas.

Besides the sketch and description, information required by the NIC includes: the full name and address of the sender, whether the idea is already developed beyond the written disclosure, whether it is patented or an application is pending, whether the idea has already been submitted to another Department or to a foreign country. Since the NIC does not return papers submitted to it, you must keep a copy of what you send if you want a copy, as you are sure to sooner or later.

The sender and his witnesses (two are usually enough) are also advised to sign and date the duplicate. It is better not to make a record on the original of the date of the conception or earliest disclosure to others, etc, since you might turn up still earlier dates and the difference in time might possibly be vital to you in case you met with a patent interference at some later time.

Get Things Straight

Another practical point arises in case you should file a patent application for your idea: if you later are in the employ or service of the Government neither you nor an assignee of your application will be able to sue during such employment or service for compensation for the idea, but can be reimbursed through a contract with the Government. It is better to get points like this straight at the start instead of proceeding under any misunderstanding.

While every reasonable effort has been made to insure the accuracy of the foregoing, it must be realized that the comments are heavily condensed, with consequent elimination of points that might be important in individual cases. Besides Bulletin No. 1, interested readers should obtain copies of the laws and decisions that apply, especially if they are attempting the difficult task of protecting their ideas without the help of a patent agent or attorney.

Do It Now

About all this article can do is to tell the inventor how to proceed without delay and without false hopes of compensation in case he does not file a patent application. The main thing is that you finish your sketch and written description and see that your idea reaches the NIC at the earliest possible moment so that it can be used in our defense program.

The great defense value of the occasional invention which the NIC can recommend to the Army or Navy amply justifies its inviting you to submit your ideas even though no invention of yours has ever received recognition.

✦ ✦ ✦

CHICKASAW READY FOR GROWING SOUTHERN LOAD

First 40,000-kw unit of Alabama Power Co installation at Mobile started operation in May; another is under construction and a third is scheduled for 1942. The 3600-rpm Westinghouse condensing turbine is supplied at 900 lb, 900 F by a single Combustion Engineering steam-generating unit

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Formula for Operating Results

P E Meredith, chief engineer of a 600-kw steam-engine and turbine power-generating and heating plant, gives his philosophy for getting results at low cost. Here is the story of what kind of a plant he has and how he "keeps his ship on an even keel"

OPERATION OF THE POWER AND HEATING PLANT in a modern apartment dwelling, such as the Eldorado, presents many interesting problems that test both the ingenuity and the resourcefulness of the engineer. This 30-story building is one of New York's largest and most luxurious, occupying the block front between 90 and 91st Sts on Central Park West, and contains 200 dwellings, some of them with over 15 rooms.

P E Meredith, chief engineer of the power plant, is fortunate in having as a boss E Eugene Grossman, managing director, who is no mean shakes as an engineer himself. Mr Grossman is a graduate mechanical and civil engineer with several years practical engineering experience and who, during the first World War, served as an engineering officer in the U. S. Navy. Both men talk

How to Operate a Power Plant

P E Meredith, chief engineer of the Eldorado Apartments in New York City, has his own ideas about operating power plants, which are well flavored with salty sayings becoming to a former marine engineer. His slogan is "Eternal Vigilance Keeps the Old Ship on an Even Keel". His philosophy is:

"Know your plant and what you can do with it under any and all conditions. Know your equipment inside and out by actual inspection. At the first signs of a fault, find out what it is all about and make necessary repairs as soon as possible.

"Keep your equipment clean, for regular maintenance often turns up small defects that otherwise might go unnoticed. Keep a log of plant performance and a history of plant equipment. My log is a record of each piece of equipment, so that when any question arises on a machine, I can get at vital data, such as when it was installed, when last repaired or overhauled, what former troubles were, etc."

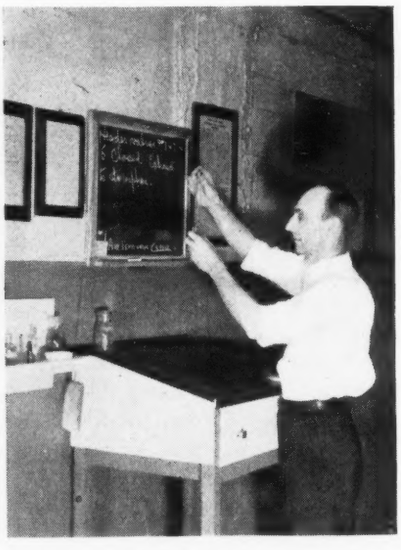


Fig. 1—Chief engineer P E Meredith gives the boiler feedwater its daily once-over. His 13 years of sea-faring experience include time as an engineering officer in the U. S. Navy during the World War and later trial engineer for three years in the employ of a large shipbuilding company. He is a graduate of the Hays School of Combustion and the U. S. Navy School of Turbine Engineering, and is a member of the NAPE

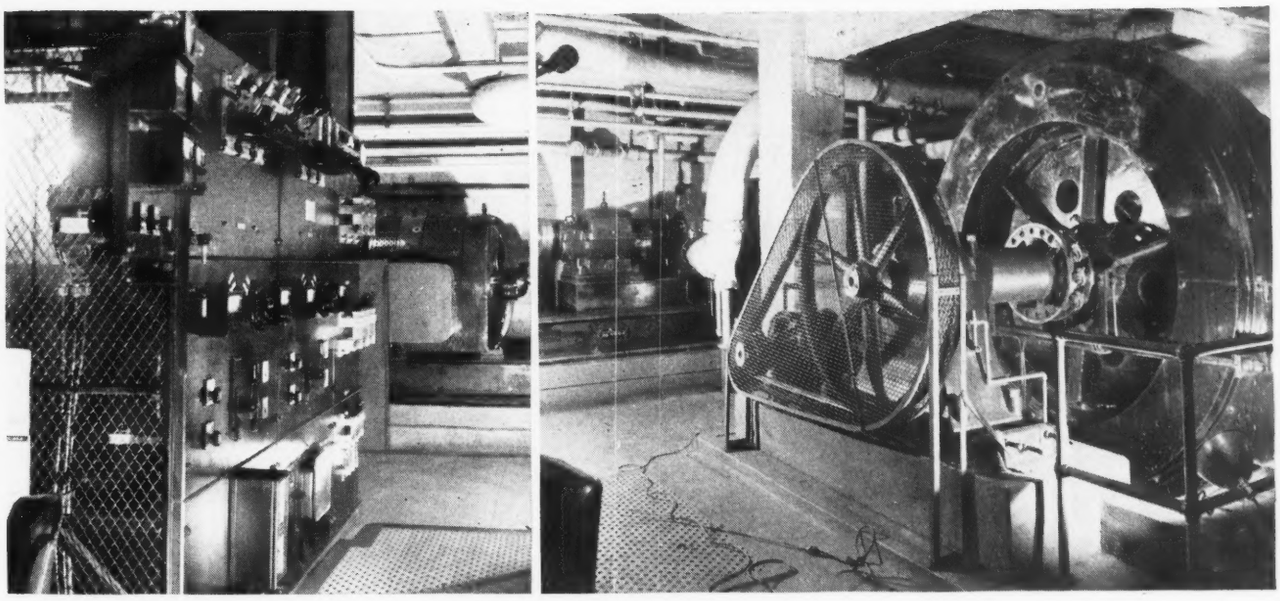


Fig. 2—At left, switchboard and 300-kw, turbine-driven ac generators; at right, 300-kw engine-driven unit

the same language and the chief has no trouble getting his ideas across to his management.

Power is generated at 208 and 120 volts by two 300-kw Crocker-Wheeler units supplying 4-wire, 3-phase, 60-cycle alternating current. One machine is driven by a 425-hp, 3600-rpm Moore turbine geared down to 1800 rpm for the generator and direct-connected exciter.

The other generator is mounted on the shaft of a 4-valve, 225-rpm Erie City Lentz engine, with V-belt-driven exciter.

Steam is supplied by two 3000-sq-ft Erie City, 3-drum, oil-fired watertube boilers designed for 200 lb g and operating at 185 lb. Each boiler is fired by three Bethlehem Dahl mechanical atomizing oil burners. Two low-pressure heating boilers, which served the building for some years before the power plant was installed, are used as feedwater-storage tanks.

In addition to the domestic load of 200 apartments, 10 variable-voltage-control passenger elevators, service-water, sump and other pumps, ventilating fans, etc, are supplied by the power plant.

BOILER AND FURNACE EFFICIENCIES

Evaporation, Per Lb of Oil	Combined Boiler & Furnace Eff, %	Evaporation, Per Lb of Oil	Combined Boiler & Furnace Eff %
12.0	65.31	14.0	76.20
12.5	68.04	14.5	78.92
13.0	70.76	15.0	81.64
13.5	73.48	15.5	84.3

BOILER RATINGS

Evaporation Lb Per Hr	Boiler Rating, %	Evaporation, Lb Per Hr	Boiler Rating, %	Evaporation, Lb Per Hr	Boiler Rating, %
3,000	29	8,000	77	12,000	116
4,000	38	9,000	87	13,000	125
5,000	48	10,000	96	14,000	135
6,000	58	10,350	100	15,000	145
7,000	67	11,000	106	15,500	150

Fuel tanks: West, 53.77 gal per in.; East, 73.06 gal per in.
Average Btu per lb of fuel oil, 18,748

Fig. 4—Chart used by plant operators to calculate boiler efficiencies and ratings

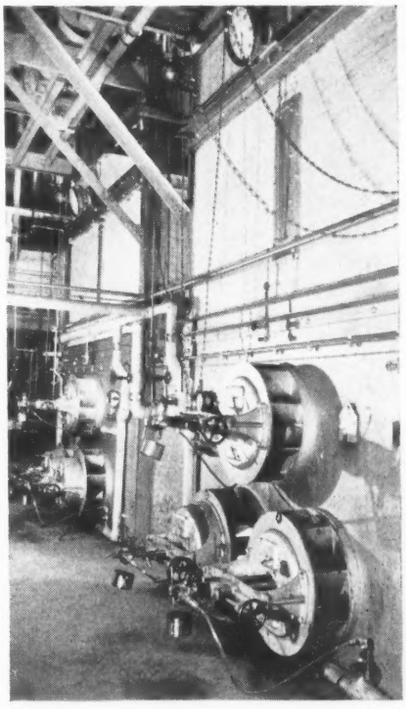


Fig. 3—Two 3000-sq-ft, oil-fired boilers operate at 185 lb gage pressure

This load fluctuates widely with morning, noon, and evening peaks.

Low-pressure steam is required for building heating, for heating an extensive installation of clothes driers in the laundry serving the 200 apartments, for heating large quantities of water, and for other services. During the heating season, all exhaust steam from power generation is required for these services. Even in summer, because of the laundry and hot-water requirements, demands for exhaust steam are high.

The clothes driers were originally gas

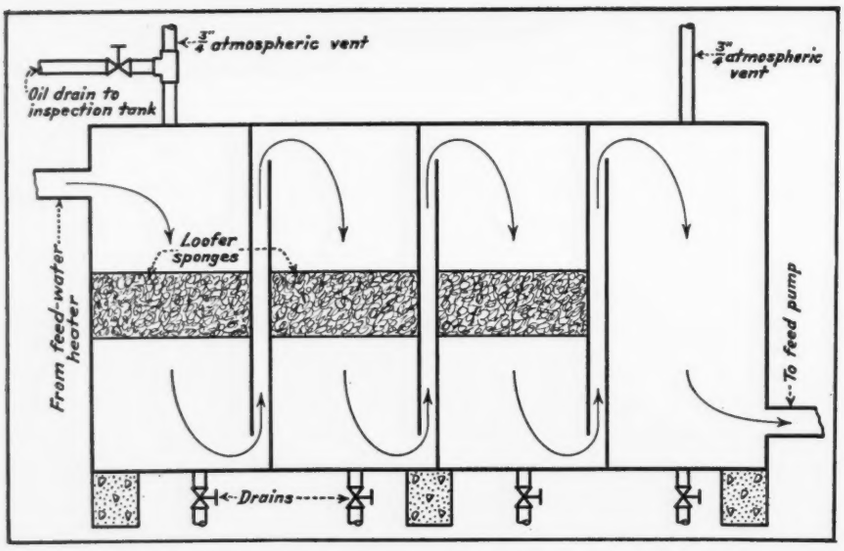


Fig. 5—Marine-type filter removes most of the oil from feedwater

heated, but were changed over to exhaust steam when the power plant was installed. One year's savings were enough to pay for the cost of the change-over.

When there is an excess of low-pressure steam, the laundry driers are left on continuously to condense as much steam as possible for feedwater. Exhaust steam is also turned into the two low-pressure boilers used for feedwater storage. The fire doors and breeching dampers on these boilers are left open, so that they become air-cooled condensers to supply whatever condensate they can for feedwater.

As many of the tenants are away during the three summer-holiday months, power load is also much lower than it is in winter. Consequently, available exhaust steam is reduced during the period of minimum heating requirements.

Power-Generating Units

Either one of the power units has sufficient capacity to carry the load, which permits using them to best advantage. During the heating season when all exhaust steam is being used, the turbine unit is operated, because its exhaust is free of lubricating oil at a time when practically all boiler water is condensate.

When there is an excess of exhaust steam, the steam-engine-driven generator is operated, as it requires less steam per unit of power output than the turbine. Because of the load requirements and the way the plant is operated, a very large part of the total exhaust steam, each year, gets back into the boilers as condensate, with a resultant saving in fuel and water costs.

The switchboard is equipped with all instruments necessary for parallel operation of the two generators and an automatic voltage regulator. The boilers have an integrating meter in the feedwater and fuel-oil lines, a CO_2 indicator, an oil-tank level indicator, a smoke-density indicator and pressure gages for steam and fuel oil.

Hourly readings are taken of all meters and recorded on the log sheet. To make it easy for the operators to figure boiler and furnace efficiency from the feedwater and fuel-meter readings, the chart, Fig. 4, is used. At the top of the chart is given evaporation per pound of oil and corresponding boiler and furnace efficiency.

When the operator takes his fuel- and water-meter reading, he divides the fuel into water to get the evaporation per pound of fuel. If it is 14, he finds on the chart opposite this rate of evaporation 76.20 % efficiency. This method is not absolutely correct, but the error is small and of little account in a small plant. The chart has been very effective in interesting the operators in the plant's performance, for they can determine what the boilers are doing at any time.

The figures across the middle of the chart gives the percent boiler rating opposite evaporation in pounds per hour. When two boilers are operating, it is necessary to divide the hourly water-meter reading by two to get the rate of evaporation. Here again there is an error, but, if the boilers are kept in good condition and carefully operated, which they are, the error is small. Across the bottom of the chart are gallons per inch of oil in each tank and also the average Btu per lb of fuel oil.

Combustion air is regulated to give about 12% CO_2. It has been found that by keeping within this limit very little trouble is experienced with brickwork. The chief engineer checks the CO_2 indicator once a month with an orsat and makes necessary adjustment.

Checking Feedwater

Maintaining correct feedwater conditions is an important problem in every plant. At the Eldorado during the heating season feedwater is chiefly condensate and as a large part of the heating steam is exhaust from the main turbine, oil in the feedwater is not a serious problem. Three of the chief sources of condensate are from the building heating system, the hot-water-tank heaters and from the laundry clothes driers. All this water returns to the heating-system vacuum tank from where it is pumped by the two return vacuum pumps into the feedwater heater.

When the turbine-driven generator is operated, part of the lubricating-oil cooling water is used for boiler feed makeup and goes to the storage tanks. Any excess of lubricating-oil cooling water goes to waste.

In the summer months, when the engine-driven unit operates, feedwater consists of condensate from the hot-water tanks, laundry clothes driers and makeup water from the city mains. The latter first goes into the storage tanks. All three sources go into the heating system return tank and from there discharged to the feedwater heater by one of the vacuum pumps.

If there happens to be an excess of feedwater from the vacuum tank an overflow on the feedwater heater returns it to the storage tank. When there is an excess of exhaust steam, the clothes driers are permitted to remain on the system all the time. This increases the amount of condensate available for

(*Continued on page* 134)

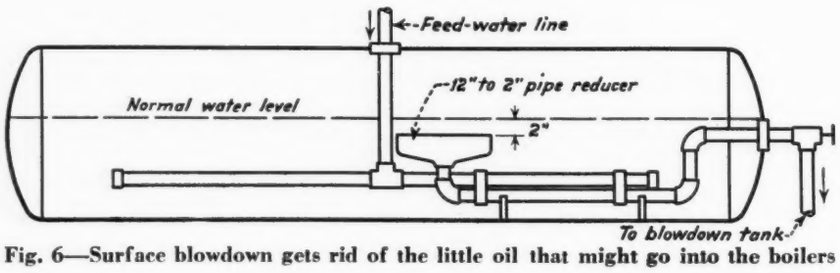


Fig. 6—Surface blowdown gets rid of the little oil that might go into the boilers

Operating Engineers Enlist for Defense Fire Protection

New York City Fire Department trains power and building engineers as a special auxiliary force to protect life and property in case of fire, explosion, or other emergency. Will soon start a school to instruct operators in this important defense work

Fairchild Aerial Surveys Photo

Engineers in New York's buildings and power plants are cooperating closely with the city Fire Dept in defense fire-protection work

MOST PEOPLE THINK of the power engineer's role in America's great defense effort as mainly a task of keeping wheels turning, steam up and machines running. But further than that, the power engineer is the key man in "home defense."

In a talk given recently before the National Association of Power Engineers, Michael J Reidy, chief inspector of the Fire Prevention Division, Fire Department of the City of New York, outlined a plan for enlisting building engineers, power-plant operators and power-service men in an emergency auxiliary force to protect life and property in case of fire or panic in the interval between the start of fire or other upheaval and the arrival of firemen, police, etc.

The main consideration, of course, is fire prevention, which has become a very important and valuable phase of fire-department work. The broad plan involves making engineers in charge of buildings "fire-prevention conscious." Building engineers and superintendents for some time have been required to obtain a Standpipe License by passing an examination on handling and maintaining firepumps, standpipes, hose, fire sprinklers and alarms. They must also organize a fire brigade and keep a fire log for inspection by the Fire Department.

From the course of events abroad, it became evident that another consideration was equally important—that of having an auxiliary force available for on-the-spot duty in case of fire, panic or explosion. Naturally the Fire Department turned to the operating engineer as the man best fitted for this work.

Men Fit the Job

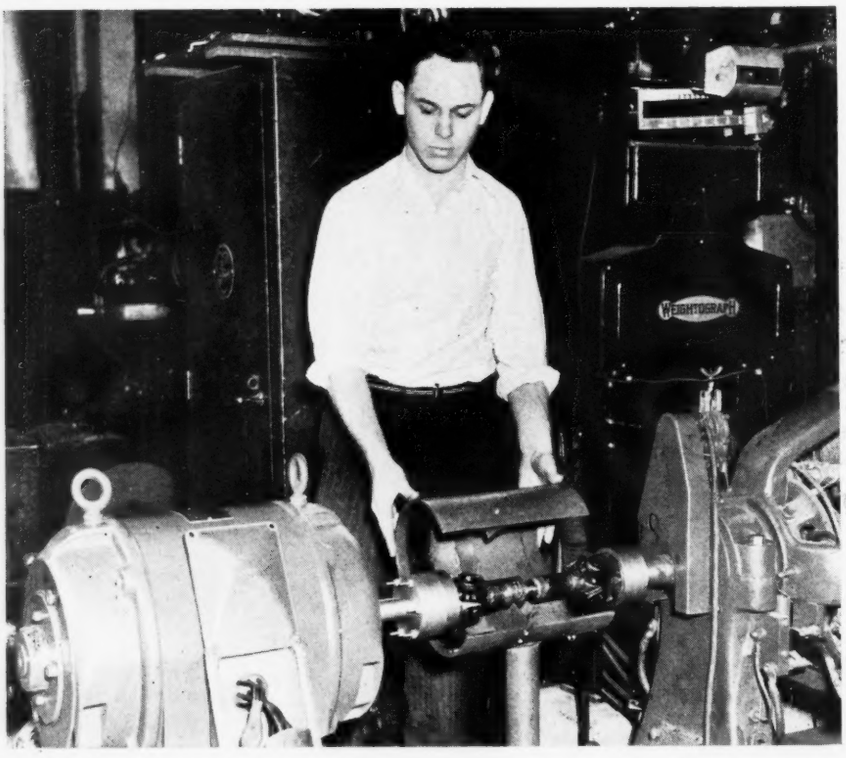
The power engineer faces emergencies many times a day. If there is a sudden leak, or a machine fails, the engineer has to think fast to get vital services restored. He is well grounded in quick decisive handling of emergencies. Moreover, the engineer is the only man who knows where the right valves are, what switches have to be pulled when something goes wrong, where fire-fighting equipment is. He is in the best position to observe unusual or suspicious activities that might lead to sabotage.

So far, the entire load of organizing and enlisting this auxiliary force has been carried out by the Fire Dept in its regular line of duty. However, at time of writing the Fire Prevention Div is working on plans for a "school" to be held two or three times a week, at which qualified men from the Fire Department will outline important phases of this work. As soon as a suitable hall is found, a program of meetings will be announced for power and buildings engineers.

Important to all America is the fact that a wide-awake municipal department is laying the groundwork for a solid defense program which ties in beautifully with fire-prevention work and is bound to produce remarkable results no matter which way the pendulum of world events swings. Prevention of fires is a problem that has been attacked by some of the best brains in this country over the past 25 years, and under the impetus of defense and national safety in time of emergency, it is getting a great deal of expert attention.

The National Association of Power Engineers has given its backing to this work, and has proposed similar programs for its members everywhere. Warren D Lewis, chairman of the National Defense Committee of the NAPE, has proposed the formation of similar auxiliaries in cities and towns all over America, and he foresees widespread action in the next few months.

PRACTICAL AIDS TO OPERATION



Universal Joints Speed Motor Testing

WE HAVE DEVELOPED and put into use an ingenious type of flexible connection to speed the coupling and uncoupling of motors under test in the laboratory and on the test floors. Standard automotive or truck-type universal joints are used. All but about 3 in. of their long torque tube is cut off and the universal joints connected in pairs by splines welded into the ends of the shortened tube. Special adapters, bolted to the outer ends of the universal joints, are in turn bolted to whatever size flange is on the motor shaft.

In test work, mechanical connections between pieces of equipment are neither rigid nor permanent and the loads imposed are frequently severe, so that there is danger a coupling may fail. Protection against this is provided by enclosing the universal joints in a specially constructed safety cover. Made from quarter-inch steel plate, these covers are 12 in. long and 7.5 in. in diameter. The lower half is welded to a 2.5-in. pipe stand or pedestal securely bolted to the floor. Hinges welded to the halves of the cover facilitate its opening. A locking lug holds the cover closed, and a collar, made of steel plate and welded in position inside the halves of the cover, fits closely around the spline to limit the length of travel of any bursting part.

Cleveland, Ohio JOHN L FULLER
Electrical Engineer, Reliance Electric & Engineering Co.

Defective Motor Causes Lamps to Flicker

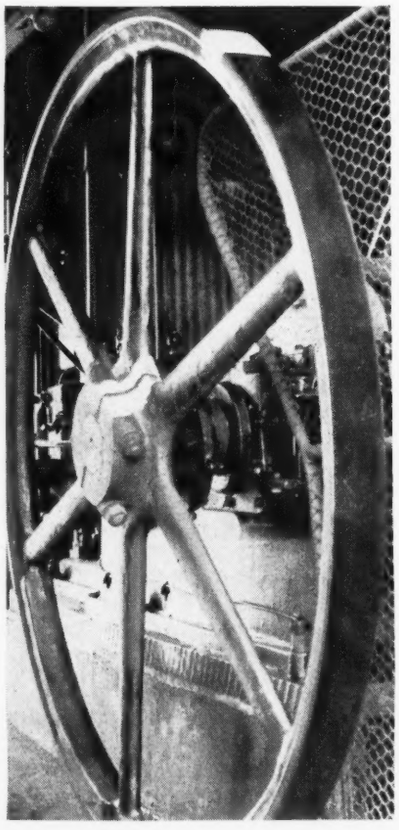
FLICKERING OF ELECTRIC LIGHTS is a common trouble which may be caused in many ways. Here is an unusual one. I was called in on one job to find why the lights were flickering intermittently after another trouble man had spent a lot of time trying to solve the riddle without success. An inspection of the lighting circuits revealed nothing that might cause flickering until I found a pumping unit operated by a commutator-type, compensated, single-phase motor that got its power from the same feeder as the lamps.

Just to see what would happen, I started the motor, which sparked very badly at the commutator. The lamps began to flicker. When the motor was shut down I found that two of its four brushes were worn so short that they did not contact the commutator. This opened the compensating winding circuit and seemed to cause a power surge to the motor. I cleaned up the commutator, replaced the brushes and started the pump again. This time the lights did not flicker.

Plainfield, N. J. H W HODGSON

Flywheel Marking Aids Gas-Engine Starting

HAND STARTING OF GAS ENGINES requires a knowledge of the firing position of the piston to do the job



efficiently. One company solved this problem by carefully determining the point on the flywheel of each engine where it fired when the piston was coming up on the compression stroke. When the piston approaches to within several degrees of the point where the charge is fired by the magneto, a white stripe was painted to the outer rim of

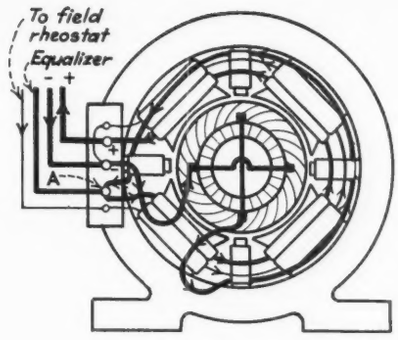
the fly-wheel at a point level with the center of the crankshaft. At the same level, another small patch of white paint was put on the hub of the fly-wheel, as in the photo.

This feature has been effective in helping to reduce accidents. It makes it possible for the mechanic who is cranking the engine to jump aside quickly when the white spots approach the horizontal position on the final stroke just before the engine fires.

Pomona, Calif. GILBERT M WILSON

Connection Upsets Load Division

PROPER DIVISION OF LOAD between direct-current generators in parallel depends, among other things, on connections being maintained in good condition. A 300-kw motor-generator set



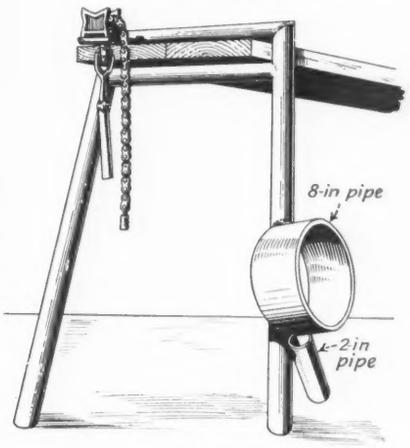
operated satisfactorily in parallel with two steam-engine-driven dc generators for about two years and then would not take its share of the load. A search revealed that the nut on the stud holding the equalizer connection between the commutating-poles and series-field-winding connections had become loose, as at *A* in the figure.

This permitted the surfaces of the connections to oxidize, develop a comparatively high resistance and overheat, a condition that prevented the equalizer from maintaining proper division of load between the machines.

Trenton, N. J. R O CUMMINGS

Pipe Sections Make Pipe-Bending Device

TO PERMIT FORMING UNIFORM BENDS in several small pipes being installed in a plant, the pipe-fitter foreman welded a short section of 8-in. pipe to one of the pipe legs of the work bench, see drawing. Below the 8-in. pipe section



and approximately tangent to it, he welded a short stub of 2-in. pipe.

By inserting one end of the pipes to be bent into the 2-in. section, he could curve them over the circle formed by the 8-in. pipe, all bends being made to the same radius. Since the bending device was only tack-welded to the bench leg, it was easily removed when the job was completed.

Houston, Texas CHARLES C LYNDE

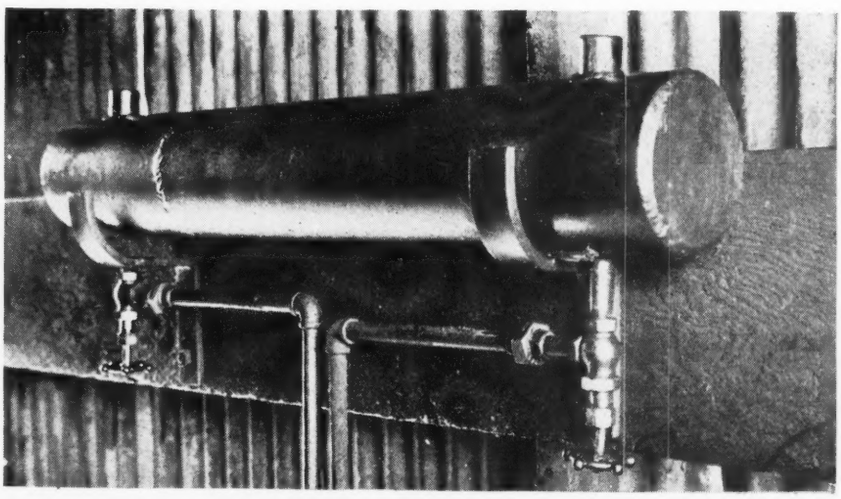
Oil Reservoir for Emergency Lubrication

A COMPANY OPERATED several single-cylinder, slow-speed gas engines without supervision other than inspection by a service man. Some of the plants were in remote places and there were possibilities that the service man might not be able to get to them for several days. If this happened the pressure lubricator might be emptied and the engines left running without oil.

To guard against this possibility, an auxiliary 5-gal reservoir was added to that of the force-feed lubricator on each engine. This reservoir was made from a 3.5-ft. length of sheet casing with its end closed by welding in circular plates, as in the photo. A hole drilled and tapped in at the bottom of the reservoir at each end was connected to the force-feed lubricator on the engine by $\frac{1}{2}$-in. pipe.

Placing the bottom of the supply tank at the same level as the bottom of the reservoir of the lubricator insured a constant flow of oil as long as any remained in the tank, which held enough oil for several days. As a safeguard against possible air-locks stopping the flow of oil through the system, an open goose-neck pipe approximately 12 in. long extends upward from a tee in the supply line to the top of the lubricator.

Pomona, Calif. GILBERT M WILSON



New Key Stops Generator Pounding

A 150-KW ENGINE-TYPE DC GENERATOR developed a pounding noise during starting or stopping or when a large change in load occurred. A manufacturer's trouble man found that the armature was loose on the shaft, the key having apparently been made about 0.001 in. too narrow. This permitted the armature to move slightly and wear the shaft undersize and the bore of the spider hub oversize.

Normally, either one of two methods could have been applied to correct the difficulty. One would be to install a new shaft, and the other would require removing the shaft and building up the worn area by welding and then

turning to the correct size. Either method would have been expensive and would have meant that the machine would be out of service for some time. The plant engineer decided against both of these in favor of a new key of the correct size, even though it might throw the armature slightly off center with the shaft and cause unbalance of the rotating element when operating at normal speed.

To put in the new key the armature was turned until the keyway was on the bottom side of the shaft. The old key was then removed and a new one fitted. Since then the machine has been operating without any trace of unbalance or pounding.

Plainfield, N. J. H W HODGSON

Reconditioned Gate Valve Disks and Seats

RECENTLY WE REMOVED A SECTION of our old steam header to make room for a new high-pressure one. This change gave us several gate valves, all of which leaked, and some of which had not been opened or closed for a long time. They were so old that it would have been difficult to obtain new seats and disks for them. As we needed valves like them in other parts of the plant we decided to try reconditioning their seats and disks.

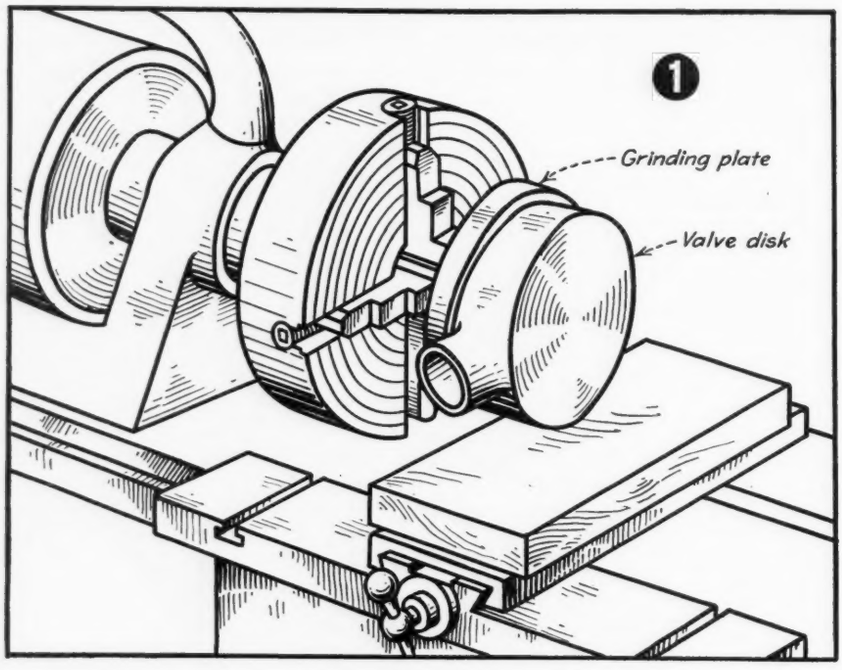
We made a metal plate, Fig. 2, slightly larger than the valve seats and machined it to a finish on both sides. One of these plates was made for each size of valve. We welded a short piece of pipe to the center of each plate and turned it true in the lathe; then bored a hole in the center of the plate. This pipe was put into the lathe chuck to turn the plate when truing the surface of the valve disk, as in Fig. 1.

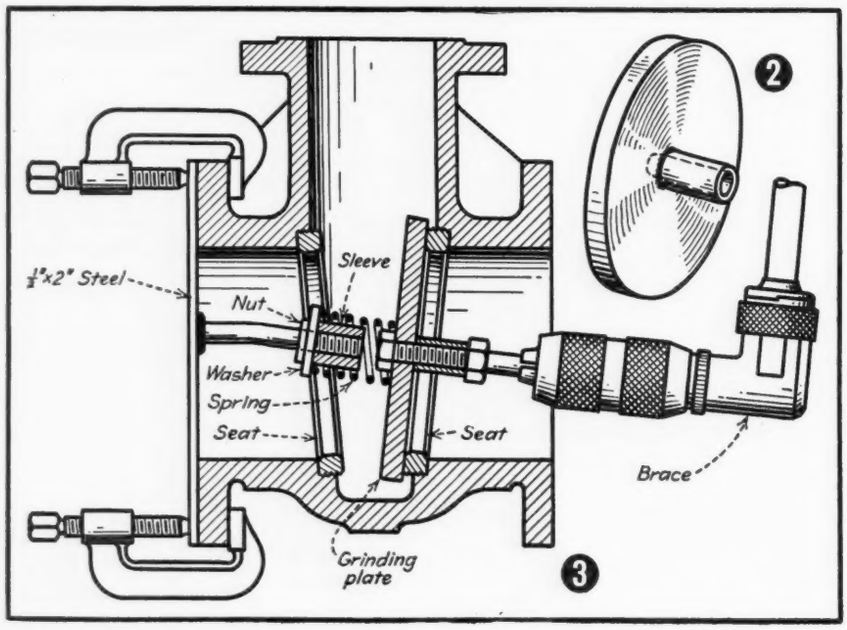
The section of pipe on the plate was made short enough so that the plate could be positioned between the two valve seats, Fig. 3. After the disk was in place between the seats a bolt was put through the hole in its center and locked into place with a nut. This bolt was made long enough to extend out to the face of the valve flange. Thus a brace could be connected for turning the disk when grinding the seats, as shown.

To hold the disk to the seat we welded a threaded stem to a piece of ½-x2-in. steel long enough to reach across the valve flange. We assembled a nut, washer, sleeve and short section of spring on this stem and clamped the steel bar across the valve flange with the spring resting against the grinding disk, Fig. 3. The length of the stem supporting the spring was made so that it would clear the disk. Desired pressure of the grinding disk on the seat was obtained by adjusting the spring tension with the nut.

With this equipment and applying the usual technique of valve-seat grinding we were able to put all the old valves in good condition.

Bismark, N. D. LESLIE BRADLEY

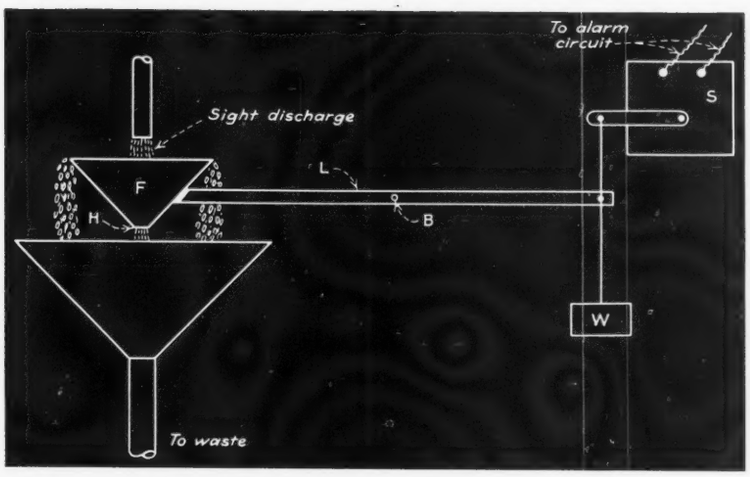




Cooling-Water Failure Gives Alarm

WATER IS USED AS A COOLING MEDIUM in compressor and oil-engine cylinder jackets, intercoolers and aftercoolers for compressed air, and in bearings. Stoppage of water flow may cause serious damage to equipment. Overheating, followed by seizing of pistons or scoring of cylinder walls, and dangerously high compressed-air temperatures that invite explosions are but a few of the difficulties that may develop.

Many types of alarms are available for indication of temperature rise or failure of cooling water. The figure shows a practical device constructed by one plant engineer. It is used on cooling systems where the water discharges from the equipment into an open sight funnel. A small funnel *F*, spot welded to one end of lever *L*, balances on bearing *B*; weight *W* is suspended from its opposite end. The



weighted end of the lever attaches to a switch *S* connected to an alarm circuit. A leak-off hole *H*, about ⅜ in. in diameter, is provided in the bottom of funnel *F*. The size of this hole should be sufficient to prevent blocking by foreign matter in the water, but it should be small enough to prevent emptying of the funnel during times of minimum cooling-water flow.

As long as cooling water flows the funnel is full and over-balances weight *W*, and switch *S* remains open. If water flow fails, the funnel empties and weight *W* moves down to close switch *S* and rings the alarm. Switch *S* may also be connected into the overload relay circuit of the controller to shut down a motor in an emergency.

Canton, Mass. HARRY M SPRING

Shims Around Boiler Tubes

WHEN ROLLING IN some new tubes in one of our boilers, we found some of the holes in the tube sheet considerably oversize. Instead of attempting to expand the tubes to fill the holes we cut thin iron strips to fit tightly between the tubes and holes and then expanded the tubes to a tight fit. The ends of the strips were filed square and fit tightly together when in the holes. Then, when the tubes were expanded the ends of the strips were forced together to form a leakproof joint.

The strips were made about ¼ in. wider than the thickness of the tube sheet and set in the holes so that they extended about ⅛ in. on each side, as in the diagram. To prevent the rings being forced out by internal pressure we rolled a bead on the ends of the tubes as shown. Putting the bushing around the tubes when the holes are too large is better practice than to expand the tubes to fit the holes. Boiler tubes have been seriously damaged by over-expanding.

New York, N. Y. S M ELONKA

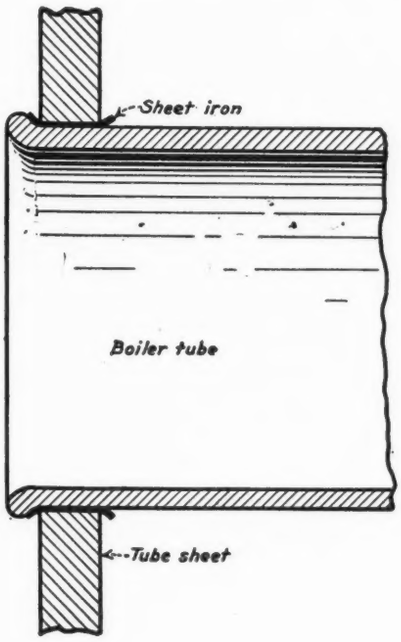
Protect Outdoor Air Receivers

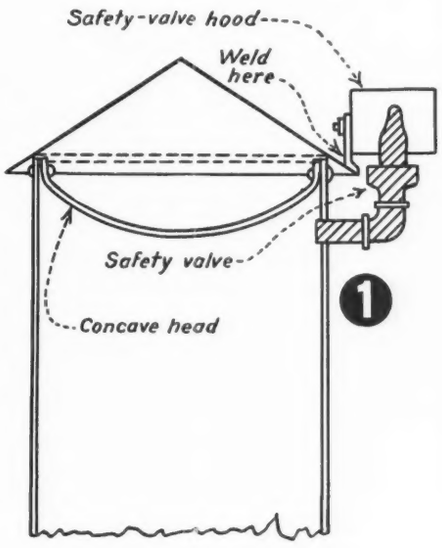
WE HAVE SEVERAL AIR RECEIVERS IN OUR PLANT, one of them out of doors, where it is continually being attacked by atmospheric conditions. To eliminate this difficulty we first considered moving the receiver inside the plant, but the cost of doing this would have been quite high, so we decided to provide a cover for it.

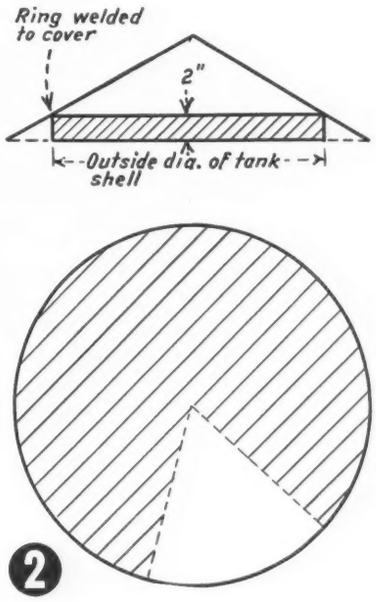
This cover we built in the shape of a cone, from 16-gage sheet steel, to protect the top of the receiver and safety valve, see Fig. 1. The cone part of the cover was first cut in a circle and a vee section cut from it so that when the vee was closed the disk took the form of a cone, Fig. 2. A sheet-metal ring 2 in. high and having an inside circumference equal to the outside diameter of the receiver was placed inside the cone to hold it in place. All joints in the cone and between ring and cone were welded.

The cover for the safety valve we made in the form of a sheet-steel cylinder closed at its top and supported over the valve from the main cover, Fig. 1. This construction is easily and cheaply made, affords adequate protection and is easily removed for receiver inspection.

Cleveland, O. A R CIOTTI







READERS' PROBLEMS

Questions from Our Readers

Pump Priming

Question 1

THE WATER SUPPLY *for a 10-ton ammonia refrigerating plant comes from a creek about 2700 ft away. In a shack near the creek is a centrifugal pump driven by a 2-hp, 220-volt, 3-phase motor. Current for the motor and lights comes from the plant by an underground cable (No. 4 wire). Every time we operate the plant we have to walk down to the creek and prime the pump to assure suction. In severe weather we have to drain the pump to avoid a freeze-up. Are there ways of priming the pump from the refrigerating plant?*—HHT.

Reduce Stack Temperature?

Question 2

OUR UPTAKE TEMPERATURE *varies between 700 and 750 F. We have ten 1500-sq-ft, 5-tube, horizontal Dillon boilers which run at approximately 180% rating. The tubes are 3 in. diameter and 16 ft long. We use Perfection hand stokers and our draft is 1 in. The coal we are burning is 1¼-in. nut and slack from the Beckley seam. It has been suggested that we might use tube chokes to advantage to hold the gas in the boiler longer and thus reduce the uptake temperature. Perhaps some* POWER *reader can give us information that will permit correcting the above condition in an inexpensive manner.*—FFM.

SUITABLE ANSWERS from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Removing Water from Fuel Oil

Answers to April Question 1

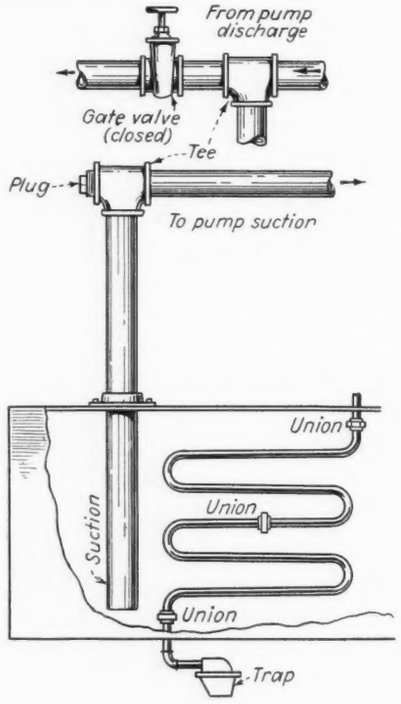
The Question

IN OUR PLANT, *we are having trouble with removal of water from our fuel oil. The oil in question is approximately a No. 5. The water content is excessive, and for some reason unknown to me the water does not seem to settle out of the oil at all. A discussion as to the reasons for this brought up the point whether or not any substance could be introduced into the tanks that would precipitate the water or which could be used with heat to hurry up the removal process. I would appreciate hearing from* POWER *readers who have successfully solved similar problems.*—HHP.

Arrange to Pump Water from Tank

IT MAY BE that HHP isn't going about the removal of the water correctly. He doesn't state whether the tank is underground or above. With the tank out of the ground, draining of water is much easier and quicker, a drain usually being provided for this purpose. With an underground tank, the water must be pumped out.

The sketch shows an arrangement for doing this. A tee is installed on the suction pipe where there is usually an ell and a tee can also be installed in the



discharge line. With the gate valve closed, water, which settles to the bottom, can be pumped out into a barrel. As soon as a good body of oil appeared I would open the valve in the discharge line and close the valve on the bypass to the barrel.

It looks to me as if HHP had a leaking steam coil. This would account for the water and the agitation caused by a leak might prevent settling out. If there are union connections in the steam coil, these are the first places to look for a leak.

Philadelphia, Pa. W T MULLEN

Try a Centrifuge

THERE ARE THREE METHODS of attack on HHP's problem: heat, mechanical separation, and absorption. Any of these will remove the water from his fuel oil. Since he should preheat his oil anyway, the application of heat will take care of most of his problem. The method of mechanical separation can be explained to him by any dairy farmer and perhaps he can buy an old cream separator from the same farmer. The third method involves the use of anhydrous chemicals to absorb the water.

I personally favor the centrifuge method with either a cream separator adapted to the job, or better, a commercial centrifuge. This will be cheaper in the long run.

Chicago, Ill. J S BROWN, JR

"Take It On the Chin" and Burn the Oil

HHP'S PROBLEM sounds very familiar. I once had close to 350,000 gal of a mixture that by test was close to one-third water. I tried letting the oil stand in the tank undisturbed; a little water separated out so it could be drained off—but not much, not enough to make any difference. In fact, subsequent tests of the oil disclosed a large part was so completely emulsified that no amount of centrifuging would effect separation. The oil companies, will, I believe, verify this characteristic of fuel oil and water.

Next we tried boiling out the water by elevating the temperature of the mixture—that is, putting all the steam we could get on the coils and heating up the whole tank. This proved ineffective. We might have been more successful had we possessed some smaller tanks in which we could have "batch-treated" the oil. Besides there was a hazard here, due to the fact that oil-water emulsions foam violently when heated to a certain temperature. A few gallons of emulsion in an oil barrel, when heated sufficiently, will fill and overflow the barrel.

There seemed to be but one other possibility—chemical separation. A firm prepared and equipped for doing such work was called in for an estimate. They were willing to guarantee results—and I have reason to believe they could have made good—but their price per gallon of recovered oil was approximately equal to the inventory value of the oil in question. Besides which we would have had to furnish all necessary treating tanks, pumping power, lights and other accessory services and materials.

On such a basis, it seemed we would have broken even by just throwing the oil away. However, State regulations regarding oil in streams being what they are, it was difficult to do this, either. Besides there was still some heating value left and the oil would burn, although with some difficulty. We decided, therefore, to "take it on the chin" and burn the oil as best we could, letting boiler-room efficiencies fall where they would. A week's intensive effort did the job as far as disposing of the bad oil was concerned. In the meantime we had taken positive steps to keep water out of the oil in the future (see POWER, July, 1940).

Just one other suggestion to help out

if HHP decides to burn up his oil. If his storage tank has sufficient additional capacity, he might add some fresh oil and mix it thoroughly with the contaminated oil, thus reducing the percentage of contamination and thereby reducing the difficulties connected with burning.

Tecumseh, Kan. H M NAYLOR

Use Filters and Centrifuge

INTRODUCTION OF ANY SUBSTANCE into the fuel tank for removing water is not recommended. To be effective, an acidic or basic material, which will readily react with water and not with the oil, is required. Such compounds as calcium chloride or sulfuric acid will remove any trace of water in the fuel. However, acidic compounds will form and drop to the bottom of the tank. These compounds are highly corrosive to steel tanks. Also, soluble corrosive acids may remain in the fuel and will affect engine parts, particularly injection plungers and barrels.

The only really satisfactory way of handling HHP's problem is to check the fuel system thoroughly, from the point of entry into the tank to the point of injection in the diesel combustion chamber. These hints may prove helpful.

The water and sediment value in a No. 5 fuel oil should be no more than 1% as determined by the Basic Sediment and Water test. If this value is exceeded appreciably, either special treatment of the fuel must be employed or the fuel should be rejected. While the practice is by no means general, the fact remains that it is highly desirable to filter the fuel before it enters the storage tank. This preliminary cleaning reduces the amount of sludge settling in the tank, removal of which is costly. Atmospheric condensation on tank walls cannot be helped and, as a rule, has a negligible effect on the fuel. To offset this effect, fuel should be permitted to settle between two and ten days.

When Bunker C or other heavy oils are burned in a diesel plant, centrifuging is imperative. It is also advisable with many of the lighter oils. As separation is better at low viscosities, heavy fuels should be heated before entering the centrifuge. Most present-day centrifuges are fitted with electric heaters and temperature control. If no outside source of heat is available, the installation of heating coils utilizing the engine cooling water will usually soon pay for itself. These coils should have enough area to hold surface temperature of the coils to not more than 150-170 F. At higher temperatures heater deposits may become troublesome, especially where residual or cracked fuels are used.

Between the centrifuge discharge and the injection-pump inlet there should be at least two filters. The first should be of mesh having a spacing of 0.004 in. or less. Following this there should be a bag filter, using shammy materials instead of cloth or waste fabric. This will assure removing any water which was not settled out in the tank or centrifuge. If the system of fuel handling is set up along the lines indicated above, HHP's trouble should be cured.

New York, N. Y. BRIAN CORRIGAN

Use a Settling Tank

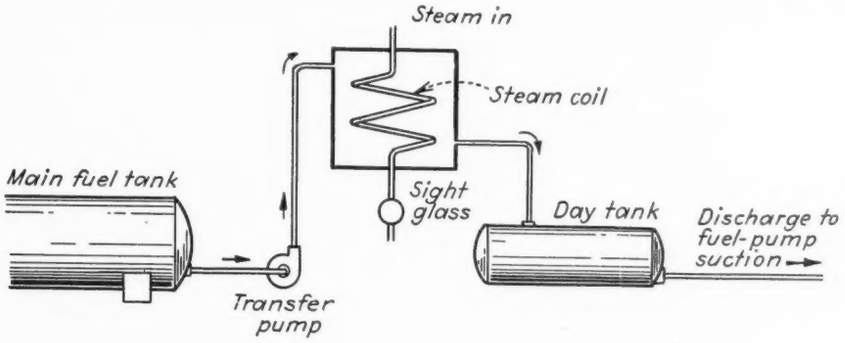
HHP DOES NOT GIVE many details in his question. However, on the assumption that the condition of excess water in the fuel oil is permanent, I suggest the following: (A) installation of settling tank with steam coils, (B) use of a centrifuge.

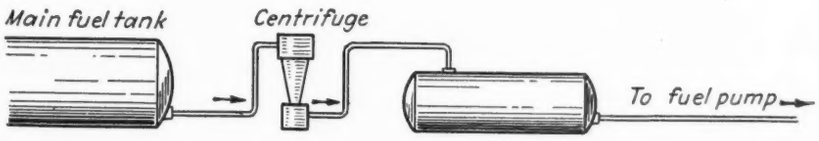
A typical settling-tank hookup is shown schematically below.) The transfer pump takes its suction from the main fuel tank, discharging into the settling tank. The exact capacity of this tank cannot be given, but it is safe to say it should be at least 25% in excess of the amount of fuel consumed in one operating watch. The steam coils may be circular in shape or may be made to conform with the tank shape. The coils should be provided with a valve to regulate steam flow and the drip should empty into a well-lighted sight glass so a leak can be detected readily.

The main fuel pump can take its suction from the settling tank, or if possible, the settling tank should discharge to a small day tank. The fuel pump can then take its suction from the day tank, discharging to the fuel-oil heaters and to the burner header. This layout has cured many cases of water in fuel oil. However, it is expensive to install and requires an excessive amount of floor space.

Another method that has proven successful is shown in the bottom sketch. A small transfer pump is installed between fuel tank and centrifuge, if there isn't sufficient elevation for gravity flow. The discharge from the centrifuge goes to a day tank, from where the fuel pump takes its suction. Selection of a centrifuge should be put in the hands of a responsible engineer. The clarifying capacity of the centrifuge must be adequate. The centrifuge will remove most, if not all, traces of water in the fuel. Sludge, and insoluble and abrasive material will also be removed, thus giving the fuel system maximum protection. A centrifuge might pay for itself in one or two years.

New York, N. Y. T G HICKS



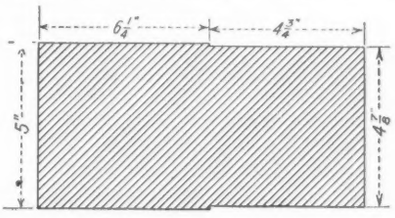


Loose Crank Pin

Answers to April Question 2

The Question

THE CORLISS ENGINE *I am running is 18x36 and runs 95 rpm at 140 lb pressure. It has pulled the crankpin loose twice in the*



disk. Both times the pin has been shrunk in the disk. The diagram shows dimensions of the pin. I am wondering if any power engineers can tell me what is causing this difficulty.—AW.

Hole May Be Out of True

ACCORDING TO THE LAWS of steam-engine design, all the dimensions of the crankpin and disk of this engine are correct. So in AW's problem, the fault seems to center around the original fit of the crankpin in the disk.

Apparently the pin worked loose the first time because of improper fit in the disk. In working loose, and due to the reciprocating forces acting on the crankpin, the pin caused the hole in the disk to become slightly distorted and of uneven bore, with the result that when a new pin was shrunk in, only a fraction of the pin was in contact with the disk. Under these conditions the crankpin finally rocked its way loose again.

I suggest that AW carefully measure the crankpin hole. He will probably find it out of true by several thousandths. Rebore the hole and make a new pin, 0.001 in. per in. of pin diameter larger

than the hole. Shrink the pin in place once more. I believe it will stay in place in normal service.

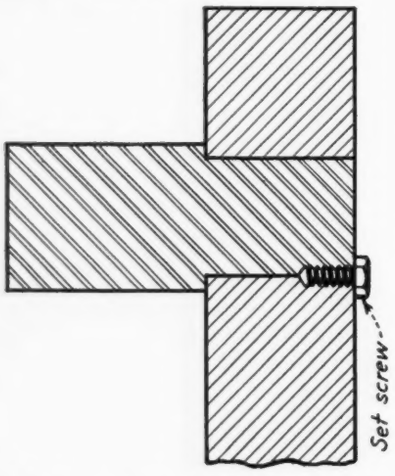
Bronx, N. Y. ANTHONY GREER

Three Causes

I WOULD SAY there could be only three reasons for AW's loose crankpin: (1) improper hole clearance in disk, (2) porous metal in disk, and (3) too great a projected bearing pressure. In the first case, the hole should be about 0.001 to 0.0015 in. per in. of crankpin diameter smaller than the pin. If the hole isn't bored out true, the pin will work loose again and all work done will be wasted.

On slow-running engines, long pins may be used to advantage, but with high-speed engines, a short pin brings the pin closer to the main bearing and thus reduces the bending stresses set up by the inertia of the connecting rod. For a crankpin of given bearing area, a long pin will run cooler. A well known engineering book states that crankpins should not have bearing pressures in excess of 300-400 lb per sq in. for stationary engines. This engine shows a pressure of 648 lb. The crankpin should have a length in the disk equal to its thickness.

Philadelphia, Pa. T F CUNNINGHAM

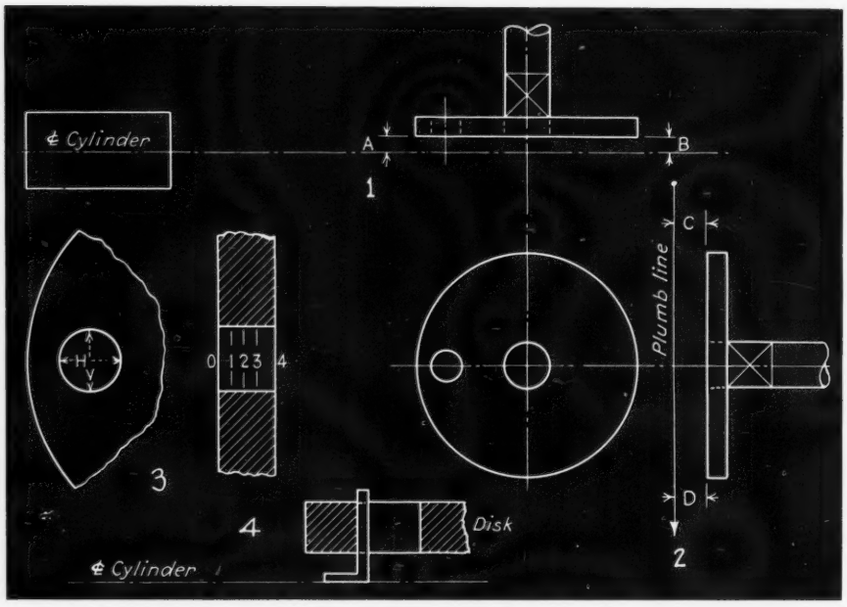


Shrink Fit NG?

AW DOES NOT STATE WHETHER, when he pulled out the crankpin the first time, he installed a new crankpin, or just shrunk the original pin back into the disk again. In any case, it appears that the crankpin is not the proper size for a good shrink fit. In this instance, about 0.005 in. larger than the crankpin hole would be correct.

Assuming that the crankpin is a reasonably good fit in the disk and the engine has to be kept in operation until it is convenient to install a new pin, and possibly rebore the crankpin hole, there are several methods of preventing lateral movement of the pin. One such method is shown in the sketch, where a hole is drilled equally between the disk and the crankpin, and tapped out for a set screw. The set screw must have a tight fit, and the hole drilled only a short distance into the shaft and disk.

Bronx, N. Y. DANIEL DONOVAN



Check Alignment

IT WOULD HAVE BEEN HELPFUL if AW had stated how long and under what conditions the engine had operated before the first crankpin had become loose. However, the following procedure and suggestions are offered:

1. Run a string line through the center line of the cylinder and extend beyond the crank disk. Check dimensions *A* & *B*, sketch 1. These dimensions should be equal if engine is properly aligned.

2. Drop plumb line from any convenient point in front of disk, sketch 2, and check dimensions *C* & *D*, which also should be equal.

3. If any of these measurements show that engine is out of line, necessary action should be taken to restore correct alignment. It has been assumed that the disk is mounted squarely on the shaft but if desired this can be checked by the use of carpenter's square or other similar tool between back of disk and shaft.

4. After correct disk alignment has been properly established, check bore of crankpin hole to see if it is square with disk and engine alignment. This can also be done with carpenter's square as shown in sketch 4. Both sides of the hole should be checked.

5. With micrometers, check dimensions of crankpin hole in both the *H* and *V* directions at points 0-1-2-3-4 as shown in sketch 3. If the hole is found to be tapered or out of round it should be trued up. If the hole has to be rebored, care must be taken so that it will be square with engine alignment. It is especially important that the condition of the hole at the outside face of the disk be in good shape as every inch or fraction thereof that the hole is not in good shape not only reduces the holding surface of the pin but also increases the lever arm working on the fit.

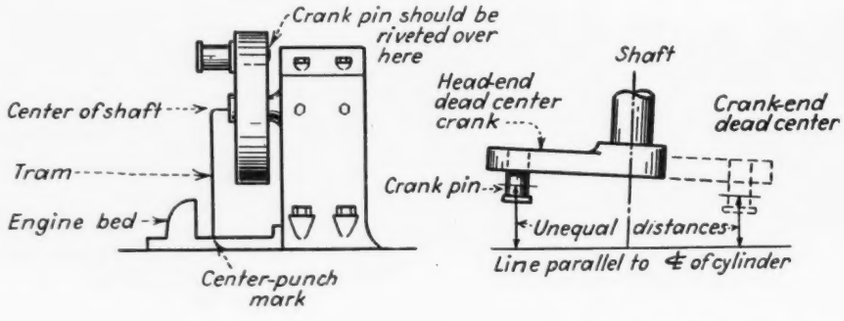
6. The portion of the pin which fits

Engine Out of Line

THE CRANKPIN should be shrunk and the end riveted over against the crank disk. The trouble seems to be caused by the engine being out of line; the main bearing may be worn, allowing the shaft to drop, or the outboard bearing pedestal may have settled slightly.

When the engine is out of line, the reciprocating connecting rod produces a flexing action on the crankpin, loosening it. This will also cause the connecting-rod bearing to heat up. Bearing wear may be checked as shown in sketch at left and the shaft alignment may be checked as shown in the second sketch.

S. Vineland, N. J. T DEROSA



into the disk should be smooth finished, allowing about .001" in diameter per inch of pin diameter for fit.

7. The disk should be heated slowly and the hole enlarged just enough for admission of the pin, after which it should be cooled slowly. As a double precaution in this particular case, a check on alignment of pin after installation with center line of cylinder could be made.

8. If the above procedure has already been followed through, it may be that if the disk is made of cast iron the material may be too soft, in which case a new disk is the only remedy.

9. The engine should, of course, be properly maintained and keyed up and free from excessive stresses due to water trapped in cylinder or other similar causes.

Pittsburgh, Pa. C J WYROUGH

Crankpin Experiences

I WILL NOT UNDERTAKE to explain why crankpins become loose, but my memory is full of experiences with them, large and small, on simple, tandem and cross-compound engines. However I would like to tell of an experience on just one pin that no one who was on the job that Sunday afternoon will ever forget.

For several years the writer was employed in a large paper mill in a Midwestern State; we had 36 engines of all makes, classes, sizes and descriptions, the meanest of which was a 400-hp cross-compound Greenwald. To those who are not familiar with a Greenwald engine, the valve was operated through gears, lay shaft and cams, thus doing away with eccentrics. This old baby was eccentric enough as it was. Old "Greeny" has a habit of loosening a pin quite often and when this happened all hands turned to, to get her going again, as she pulled a string of Jordans and beaters and without them rolling no paper could be made. One Tuesday night the low-side pin started to pound. We kept her going until Thursday noon when the Chief ordered her down. In this mill we did all our own work; we were quite adept in making hurried repairs. The Chief had a law, and that was, that every one (both shifts) stand by until the paper started to roll, with the result that this particular time we had more help than needed.

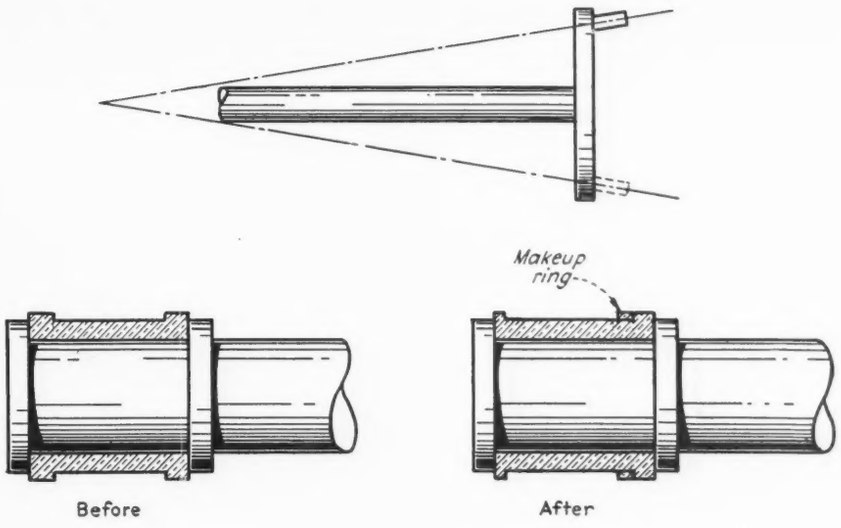
It did not take long to get the brasses and rod off. In the past it had been very easy to drive the pin out of the disk, but this day was an exception and the pin could not be started, so we began to drill with an "Old Man" (made especially). Friday and Friday night we pulled that old man into the pin and about 2 P.M. Saturday it was loose enough to drive out. We then discovered the hole in the disk was egg shaped, so we rigged up a boring bar and started to true up the hole. In the meantime the machine shop was making the new pin. Sunday morning the hole was done and all we had to do to complete the job was heat the disk, "sink" the pin, and dress her up so she would be ready to start on the 5 A.M. shift Monday morning.

We had made a blow torch from a piece of pipe to use in heating the disks (sinking pins was old stuff with us). At about 2 P.M. this Sunday the disk was hot, the pin was ready (in a bucket of ice water) and standing around were about 30 engineers, oilers, machinists, firemen and others. This contributed to our downfall.

The Chief was very methodical in all his operations. Every man was assigned to some particular duty and expected to carry out his orders, so he started something like this: "Now men, we are about done and here is what I want each of you to do from now on. Clayt, you take two men and remove the torch. Al you and your helper remove the brick and asbestos from behind the disk. Harry you get that sledge and stand over here. Ed you get another sledge and stand here. Mac you get that 4 x 4 and stand here. Now when I say the word, Clayt, get rid of that torch and you, Al, get busy on those bricks. Clyde, you take the pin and put it in the hole and as soon as it is started get against it Mac with your 4 x 4 and Harry and Ed give it Hell."

So far so good. At that time he happened to see yours truly getting set to

(*Continued on page 142*)



Causes and Cures

A LOOSE CRANKPIN might be caused by a twisting effect of the connecting rods push and pull, the twisting being due to the crankpin not being paralled to the crankshaft. Misalignment of the crankpin may be due to: (1) poor material in crank, (2) poor workmanship in boring or reboring the crankpin hole, (3) a warped crank, (4) connecting rod not square with crankpin.

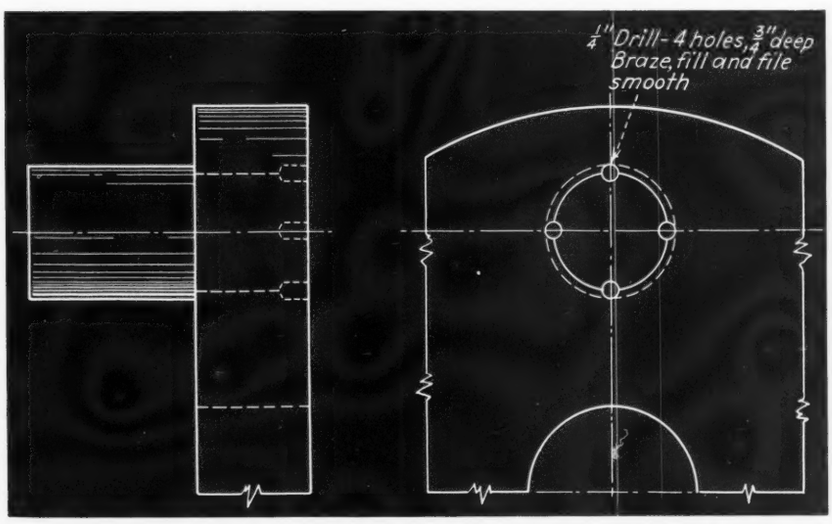
The cures are: (1) a new disk, (2) rebore parallel to the crankshaft, (3) same as (2), and (4) square up the connecting rod with the crankshaft by altering thickness of the flanges on the big end brasses. In detail, the crankpin in troubles 2 and 3 will describe a cone, as shown exaggerated in the sketch. Hence the twisting of the pin. The sketch also shows how reducing one flange and adding a makeup ring to the inside of the other flange makes the connecting rod move outwards.

Long Beach, Calif. PERCY BROMLEY

In a Nutshell

The sketch below covers my suggestion for AW's loose crankpin.

Los Angeles, Calif. ERICH SCHENK



Figuring Steam-Engine Efficiency

By PHIL SWAIN

I RATHER HATED to tackle this subject because there is some confusion about steam-engine efficiencies—but it had to come sooner or later. For most machines efficiency is very easy to figure, as was clearly demonstrated on this page last month. Here's the rule again: *The efficiency of any machine is merely its useful output divided by its input, both measured in the same units of power or energy.*

This rule is entirely correct for a steam engine or turbine if you clearly understand what is meant by input in this case. Since the input is heat, it is easy to jump to the wrong conclusion that the input is the heat* in the steam supplied to the throttle of the engine or turbine.

Actually the heat in the throttle steam, by itself, means nothing in terms of engine heat consumption, because this heat is measured above 32 F, which is an arbitrary point and bears no relation to the facts of plant operation.

Another point to remember is that the engine turns some heat back to the boiler in the form of feedwater, and should get credit for the hottest feedwater its exhaust could produce—that is for the hot water at the saturation temperature corresponding to the pressure of the exhaust steam. Subtract the heat in that water from that in the throttle steam to get the net per pound charged against the engine.

This subtraction eliminates the effect of the 32-F base, and leaves an absolute amount of heat, just as the difference between the two elevations, both measured above some arbitrary sea level, is the true distance you would climb in going from the bottom to the top of the chimney shown in Fig. 2.

In Fig. 1, the engine takes in superheated steam at 400 F total temperature and 150 lb g pressure and exhausts at 5 lb g pressure. The steam tables show that the heat in this throttle steam is 1217 Btu per pound, and that the heat of the liquid at exhaust temperature is 196 Btu. The difference (chargeable to the engine as input) is 1021 Btu per pound. (See Fig. 2 also).

If the engine uses 30 lb of steam per horsepower hour,

Input per hp hr	= 30 x 1021 = 30,630 Btu
Corresponding useful output (1 hphr)	= 2544 Btu (from last month's table)
Efficiency	= 2544 ÷ 30630 = 0.083 = 8.3%

Exactly the same method of computation is used if the engine or turbine exhausts to condenser, provided no steam is bled from the unit. Where steam is bled for feedwater heating only, the turbine supplies the boiler, in effect, with feedwater at the exit water temperature of the feed heater fed by the highest bleed point. Therefore, for each pound of steam delivered to the throttle, charge the turbine with the heat of throttle steam minus the heat in the water leaving the last feed heater.

Attempts have been made to standardize the figuring of efficiency where all or part of the exhaust steam and bled steam goes to heating and process, but there is no general agreement as to how such cases should be computed.

It is clear, however, that any heat supplied to process by exhaust or bled steam really becomes part of the *useful* output. Thus, where no steam is lost to condenser or atmosphere, it is sensible to look upon a steam engine or turbine as having an over-all efficiency of 80 or 90%. In that case, all heat supplied is usefully employed except that small portion lost in external friction, radiation and electrical losses. Nevertheless, it is customary to figure the efficiency of any backpressure engine or turbine as if all of its exhaust heat were completely wasted except the small portion that could be absorbed in heating feed water.

An engine that figured very low in efficiency on this basis might in fact be part of a phenomenally efficient plant if all exhaust were utilized for process and heating.

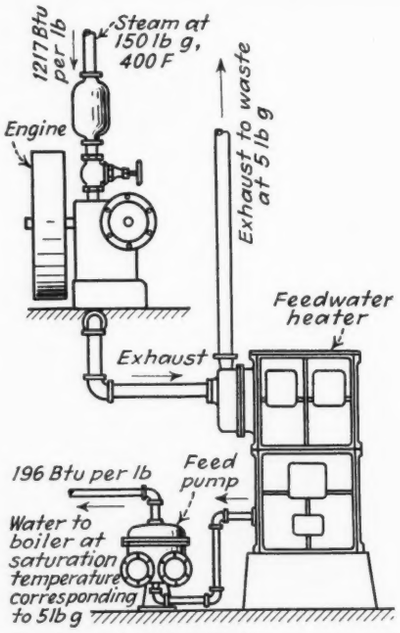

1217 Btu per lb
Steam at 150 lb g, 400 F
Engine
Exhaust to waste at 5 lb g
Feedwater heater
Exhaust
196 Btu per lb
Feed pump
Water to boiler at saturation temperature corresponding to 5 lb g

Fig. 1—In figuring efficiency of steam engine by customary method the engine gets no credit for exhaust steam delivered to heating and process

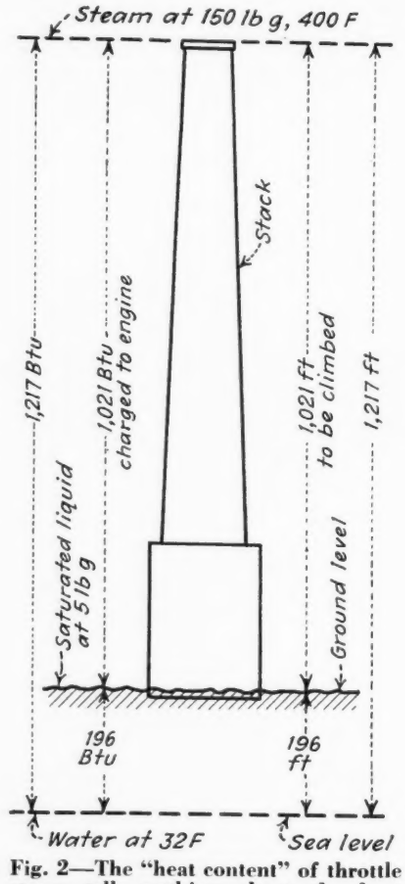


Fig. 2—The "heat content" of throttle steam tells nothing about the heat consumption of the engine per pound of steam used. Difference in heat content between throttle steam and feedwater at exhaust temperature gives heat per pound chargeable as engine input

* Enthalpy is the accepted modern term, but in this elementary article we shall use the old familiar terms "total heat of steam" and "heat of the liquid".

HOW TO CLEAN BALL BEARINGS ON MOTORS

► THE PRESSURE-RELIEF METHOD of greasing motors described on page 110, May POWER, tends to purge the bearing housing of used grease. Complete cleaning of the bearings, therefore, is required at infrequent intervals only. When the motor is disassembled for overhauling, it is easy to wash the bearings with a grease solvent such as carbon-tetrachloride. When the bearings are not disassembled they can be cleaned by the following method recommended by the General Electric Co.

For a thorough and convenient flushing, use some solvent such as a light mineral oil heated to a temperature of 165 F, or carbon-tetrachloride. The latter is noninflammable, does not require heating and dissolves grease more quickly than hot oil. When using carbon-tetrachloride, however, be careful to remove all traces of it from the bearing housing and do not allow it to remain in contact with insulated windings in case of accidental splashing.

This method permits the cleaning of all standard motors operating at an angle not exceeding 15 deg from the horizontal (except totally enclosed, fan-cooled motors) without disassembly. The bearings and housings of vertical motors cannot be cleaned except by a complete motor disassembly.

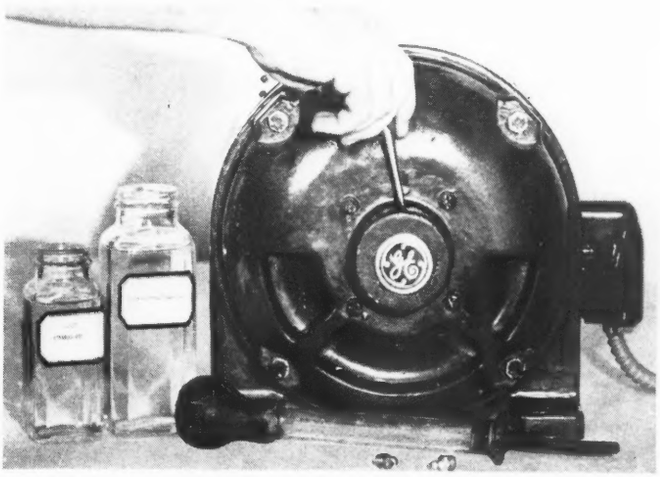
For totally enclosed, fan-cooled motors, the bearing at the pulley end may be flushed as described. To clean the fan-end bearing, first remove the fan cover and fan in order to make accessible the drain plug at the bottom of the housing. This procedure can be conveniently carried out whenever a general reconditioning of the motor is made.

1 →

Wipe clean the housing, pressure-gun and relief fittings and then remove both fittings. Every care should be taken to keep dirt out of the bearings both when greasing and cleaning them. A bit of abrasive once in a bearing may not be removed even with the most thorough cleaning. Afterwards, it may become dislodged and get between the bearing surfaces with serious results

2 →

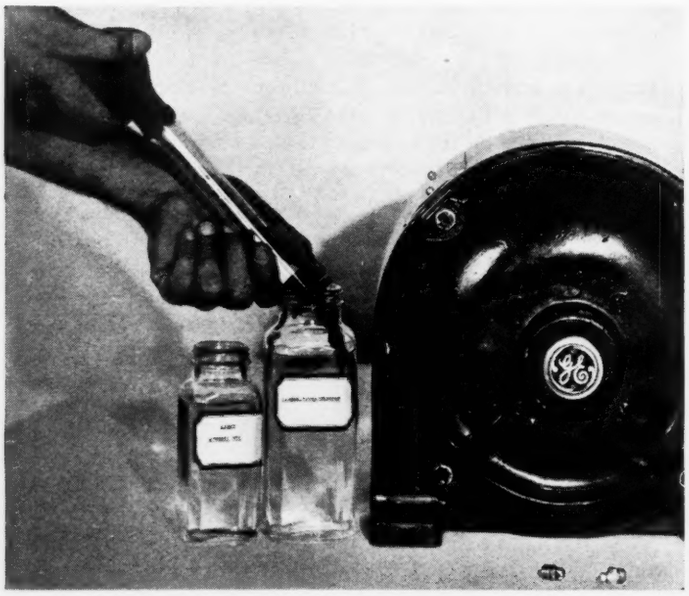
With a clean screw driver or a similar tool, free the pressure-fitting hole in the top of the bearing housing of hardened grease



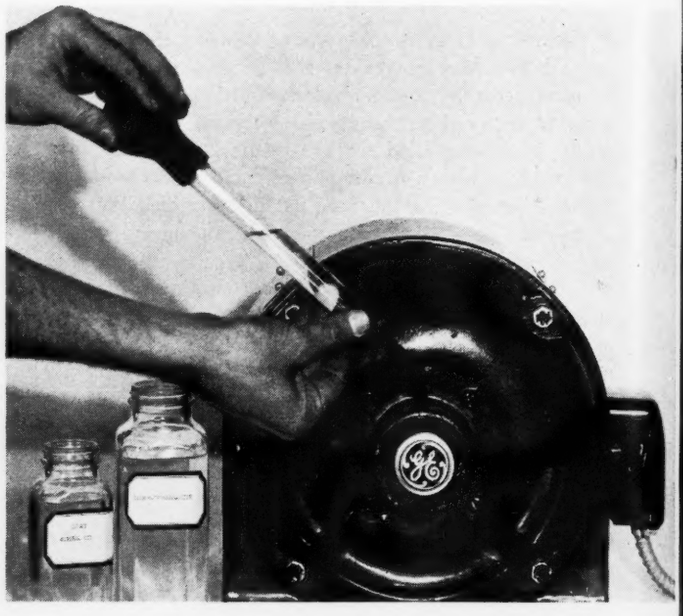
3 →

Also, free the relief-plug hole in the bottom of the housing from old grease to permit easy expulsion of the old grease during the cleaning process after the solvent is added

HOW TO CLEAN BALL BEARINGS ON MOTORS



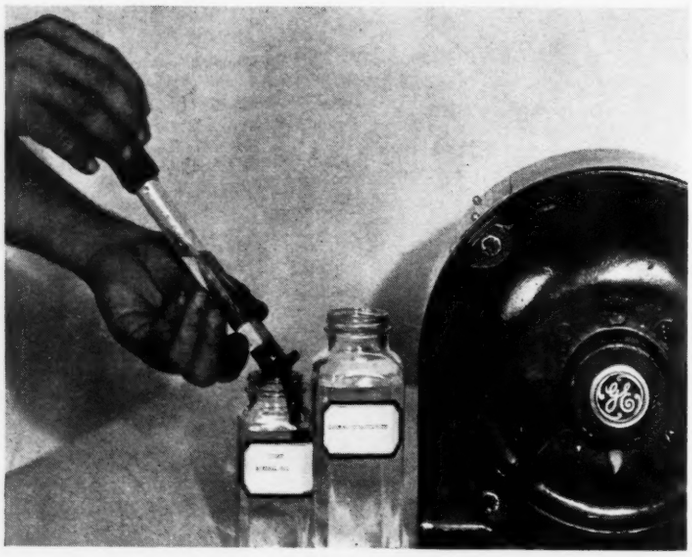
4 Fill a syringe with grease solvent and inject some of it into the bearing housing through the pressure-fitting hole while the motor is running



5 As the grease becomes thinned by the solvent, it will drain out through the relief hole. Continue to add solvent until it drains out quite clear

← **6**

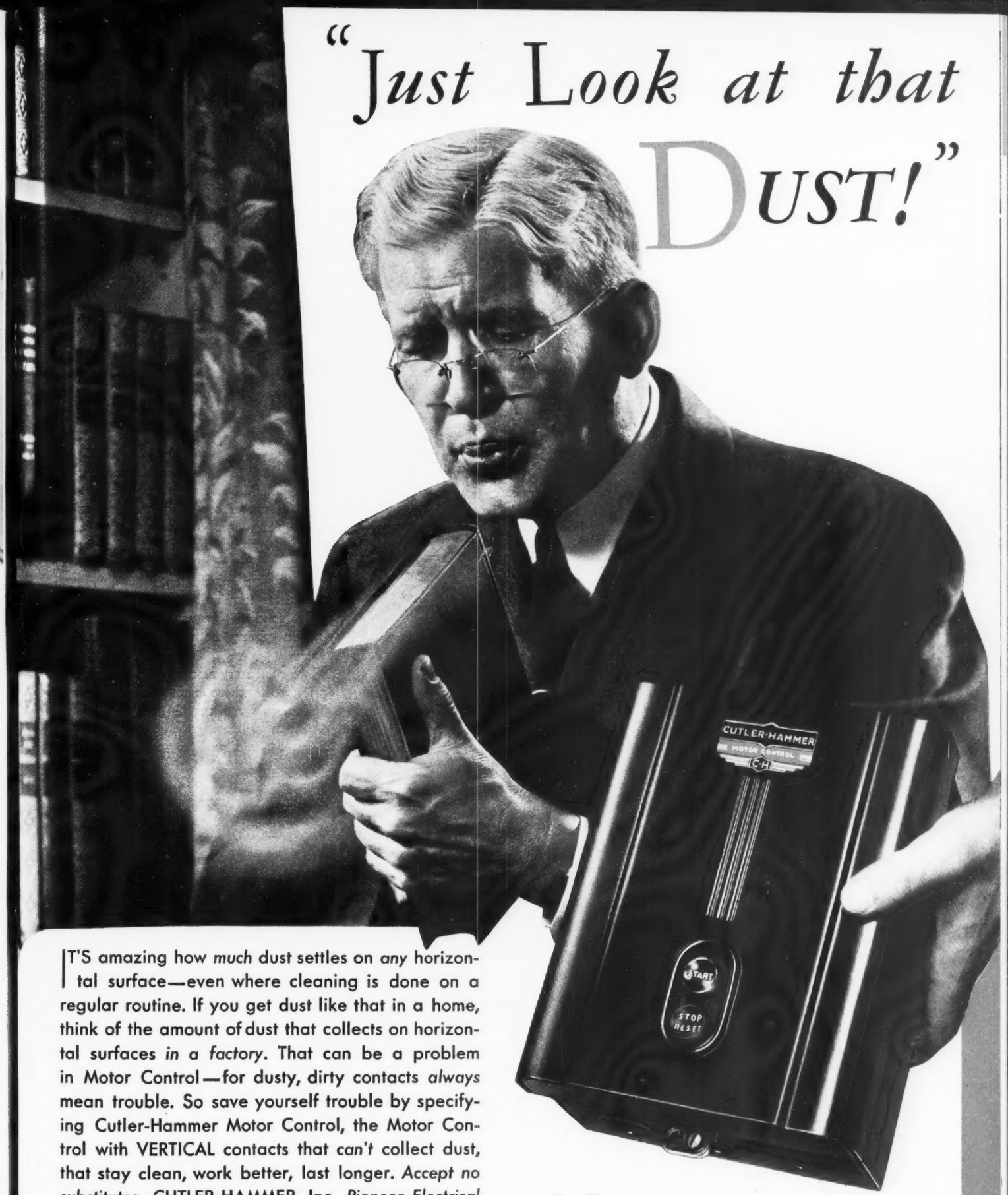
Replace the relief plug and inject solvent until it can be seen splashing in the filling hole. Allow the solvent to churn for a few minutes. Remove relief plug and drain. Repeat the churning operation until the solvent runs clean



← **7**

If carbon-tetrachloride has been used for flushing, replace the relief plug and inject a small amount of light lubricating oil. Allow it to churn for a minute or two before draining off. This will flush out the solvent. To complete the job, grease the bearing, using the method described in May POWER

"Just Look at that DUST!"



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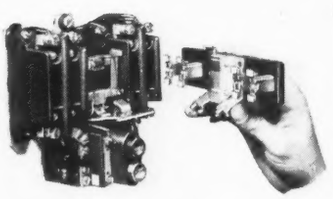

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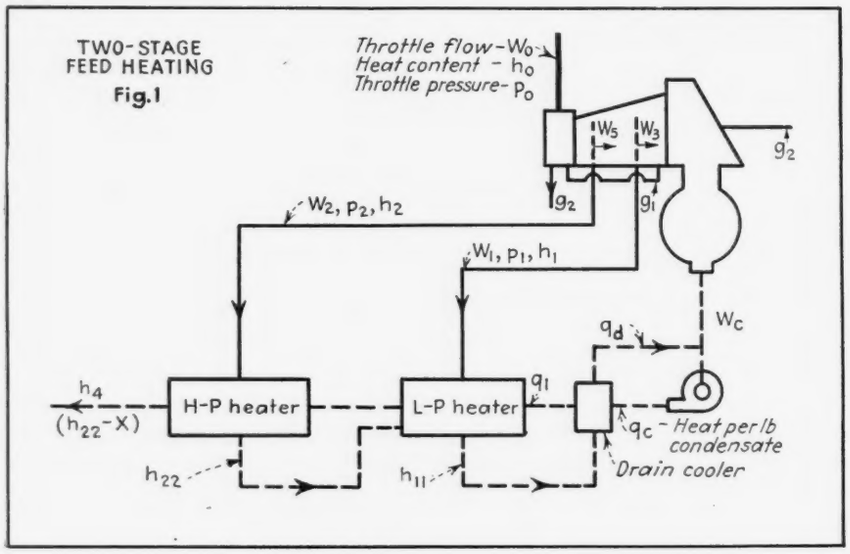
Standard Form For Turbine Heat Balance

Calculating feedheating-turbine performance from manufacturer's data should be part of every steam power man's knowledge. You can take your algebra or let it alone with this standard method—see page 114 for worked-out example



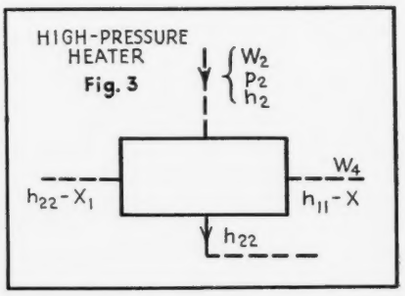
By E V POLLARD
Turbine Engineering Dept, General Electric Co, Lynn, Mass.

▶ A STEP-BY-STEP CALCULATION of the heat quantities of each feedwater heater greatly simplifies both the understanding and actual labor of working out a turbine heat balance. By a relatively simple trial-and-error step, the computation becomes one of ordinary arithmetic.

The method, detailed on the following page, follows an assumed quantity of condensate from the condenser hotwell through various heat exchangers to the boiler. The heat balance of each heater is calculated separately. All heat from other sources is considered as it enters each heater. Simple algebraic formulas are derived and given here to express the quantity of steam bled from the turbine to each heater in terms of heat quantities that can be readily calculated or estimated.

By using a numbered line for each step, the form provides a place for recording each individual calculation. The form can easily be extended to cover more complicated heat-balance diagrams involving several stages of feedheating.

Starting with the relatively simple flow diagram of Fig. 1, follow through three steps: (1) an algebraic analysis of heat balance of each heater separately, (2) calculation of the heat entering the feedwater as it flows from condenser to boiler, and (3) numerical calculation of heat balance.



Some knowledge of the turbine performance and heaters must be available from the manufacturer or from test results. These are (1) non-extraction flow and output, that is, the straight-condensing steam rate, (2) extraction-stage pressures and enthalpies, (3) (3) heater terminal differences in Btu per lb, and (4) pressure drop in extraction piping between turbine and heaters.

Two customary assumptions give very close results where exact values are not available. These are (1) the enthalpy of condensate leaving the hotwell is that of saturated liquid corresponding to absolute pressure in the condenser, and (2) enthalpy of feedwater does not change as it passes through the feed pumps.

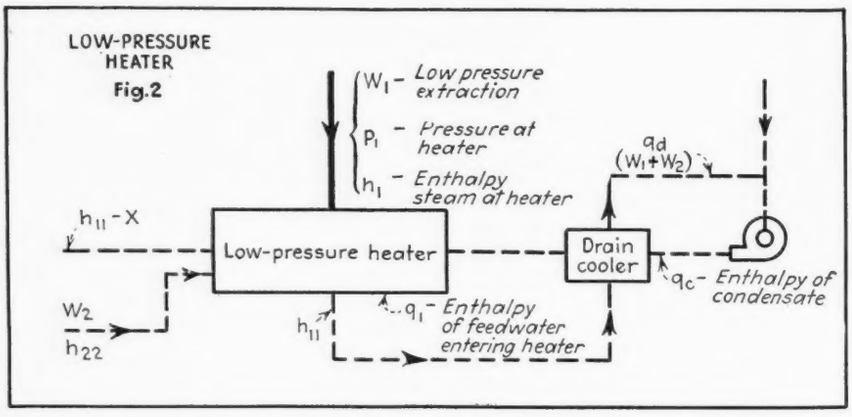
The algebraic analysis of low-pressure heater and drain cooler of Fig. 2 is presented here as the basis for the computation form which follows:

Heat taken up by feedwater in heater is

$$(W_e + W_1 + W_2)\,(h_{11} - X - q_1)$$

where W = condensate flows at points indicated, lb per hr; h and q = en-

(Continued on page 116)



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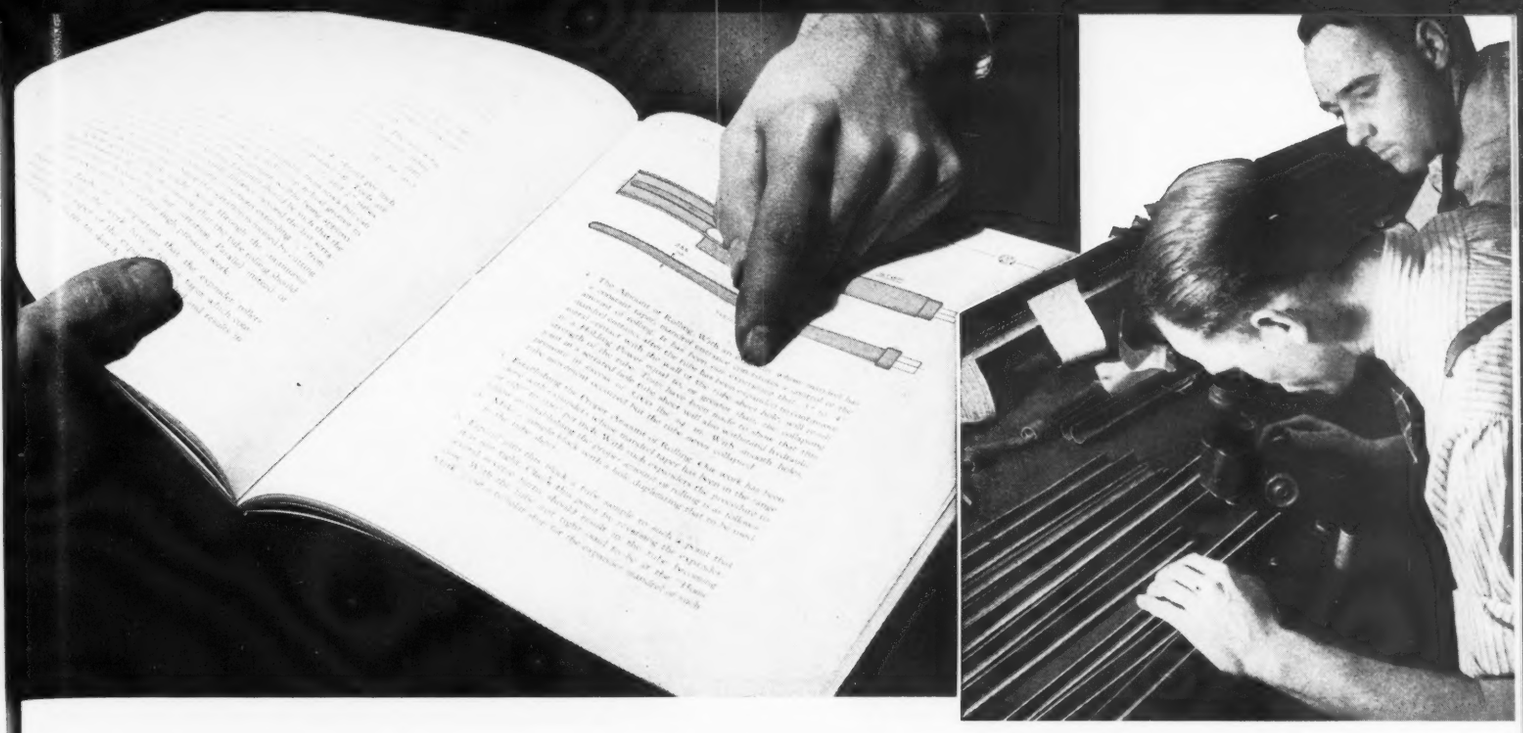
Standard Form for Turbine Heat Balance

(Continued from page 112)

TURBINE EXTRACTION FLOW—CALCULATION PROCEDURE FORM

ITEM	SYMBOL	EXPLANATION	CALCULATION	NUMERICAL EXAMPLE		
1.	W_e	Steam to condenser, lb per hr	Assume	65000	.....	.....
2.	g_2	Low pressure gland seal, lb per hr	Given	300	.....	.....
3.	g_1	High pressure gland flow, lb per hr	Given	500	.....	.....
4.	q_e	Enthalpy of feedwater leaving condenser hotwell, Btu per lb	.....	60	.....	.....
		Low-Pressure Heater				
5.	W_3	Flow to stage following extraction opening, lb per hr	(1) − (2) − (3)	64200	.....	.....
6.		Shell pressure in turbine, lb per sq in. abs	At (5)	11.2	.....	.....
7.	h_1	Enthalpy of steam in turbine, Btu per lb	At (6)	1130.5	.....	.....
8.		Pressure drop to heater, lb per sq in	Given	1.1	.....	.....
9.	p_1	Pressure of steam in heater, lb per sq in. abs	(6) − (8)	10.1	.....	.....
10.	h_{11}	Enthalpy of condensate in heater, Btu per lb	At (9)	161.3	.....	.....
11.	X	Heater terminal heat difference, Btu per lb	Given	5.0	.....	.....
12.		Enthalpy of feedwater leaving heater, Btu per lb	(10) − (11)	156.3	.....	.....
13.	W_2	Drip from upper heater, lb per hr	(35)	8000	8100	8040
14.	h_{22}	Enthalpy of drip from upper heater, Btu per lb	(29)	.....	267.3	267.0
15.	dh	Drain cooler terminal heat difference, Btu per lb	Given	.....	8.0	8.0
16.		$h_{11} - X - q_e$	(12) − (4)	96.3	96.3	96.3
17.		$h_{22} - (h_{11} - X) - dh$	(14) − (12) − (15)	.....	103.0	102.7
18.		$W_e (h_{11} - X - q_e)$	(1) × (16)	.....	6,260,000	6,260,000
19.		$W_2 [h_{22} - (h_{11} - X) - dh]$	(13) × (17)	.....	835,000	825,000
20.		$W_e (h_{11} - X - q_e) - W_2 [h_{22} - (h_{11} - X) - dh]$	(18) − (19)	.....	5,425,000	5,435,000
21.		$h_1 - (h_{11} - X) - dh$	(7) − (12) − (15)	.....	966.2	966.2
22.	W_1	Extraction to heater, lb per hr	(20) ÷ (21)	6000	5620	5620
		High-Pressure Heater				
23.	W_4	Feedwater to heater, lb per hr	(1) + (22) + (35)	79000	78720	78660
24.	W_5	Flow to stage following extraction opening, lb per hr	(5) + (22)	70200	69820	69820
25.		Shell pressure in turbine, lb per sq in. abs	At (24)	71.8	71.4	71.4
26.	h_2	Enthalpy of steam in turbine, Btu per lb	At (25)	1252.7	1252.4	1252.4
27.		Pressure drop to heater, lb per sq in	Given	7.2	7.1	7.1
28.	p_2	Pressure of steam in heater, lb per sq in. abs	(25) − (27)	64.6	64.3	64.3
29.	h_{22}	Enthalpy of condensate in heater, Btu per lb	At (28)	267.3	267.0	267.0
30.	X_1	Heater terminal heat difference, Btu per lb	Given	10	10	10
31.		Enthalpy of feedwater leaving heater, Btu per lb	(29) − (30)	257.3	257.0	257.0
32.		$(h_{22} - X_1) - (h_{11} - X)$	(31) − (12)	101.0	100.7	100.7
33.		$W_4 [(h_{22} - X_1) - (h_{11} - X)]$	(23) × (32)	7,980,000	7,930,000	7,910,000
34.		$h_2 - h_{22}$	(26) − (29)	985.4	985.4	985.4
35.	W_2	Extraction to heater, lb per hr	(33) ÷ (34)	8100	8040	8030
36.	W_e	Flow of steam entering turbine, lb per hr	(1) + (22) + (35)	.....	.....	78,650
		Output Calculation				
37.	h_s	Enthalpy of steam supplied, Btu per lb		.....	.....	1389.0
38.		Enthalpy drop to low-pressure extraction opening, Btu per lb	(37) − (7)	.....	.....	258.5
39.		Enthalpy drop to high-pressure extraction opening, Btu per lb	(37) − (26)	.....	.....	136.6
40.	P	Base non-extraction output, kw	At (1)	.....	.....	6900
41.	ΔP_1	Output from low-pressure extraction flow, kw	$\frac{(22) \times (38)}{3412.7}$	.....	.....	426
42.	ΔP_2	Output from high-pressure extraction flow, kw	$\frac{(35) \times (39)}{3412.7}$	.....	.....	321
43.		Net output, kw	(10) + (41) + (42)	.....	.....	7647

(Continued on page 116)

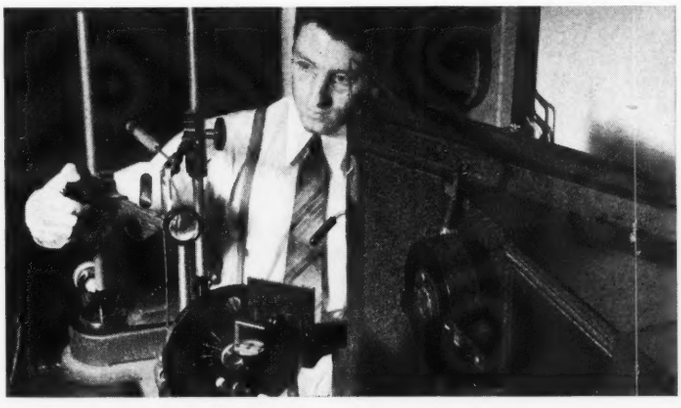


THE BOOK YOU HELPED TO WRITE

HELPS SOLVE

YOUR CONDENSER TUBE PROBLEMS

You may find in Scovill experience the answer to your Condenser Tube trouble, for Scovill's condenser service engineers have, for years, worked closely with condenser operators and manufacturers. They have encountered many and various problems—have helped solve many—kept records of all. In one, a Scovill consultant found the remedy in the addition of a small bleed line—inexpensive but effective in lengthening tube life.



In another case, a change in tube alloys made all the difference. This is particularly successful, where dezincification of Admiralty is encountered, for Scovill's patented Phosphorized Admiralty now greatly extends the life of that popular alloy by inhibiting dezincification.

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Masters of Metal

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Standard Form for Turbine Heat Balance

(Continued from page 114)

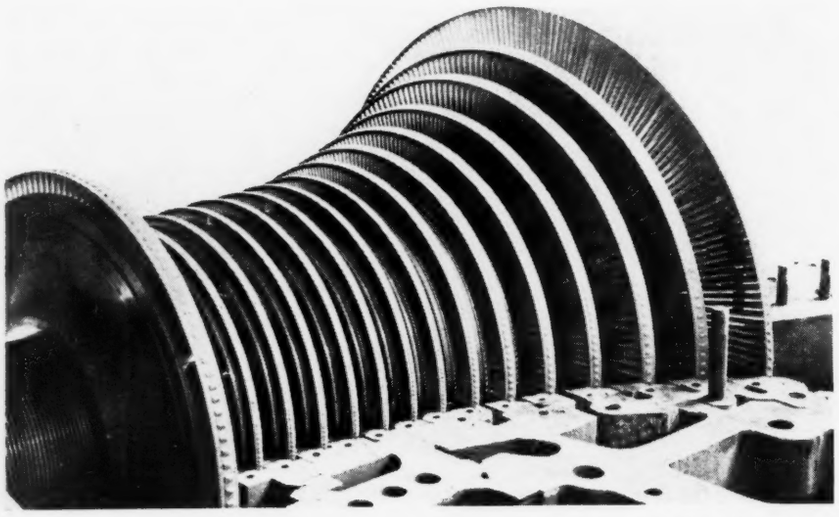

Fig. 4—Part of the lower casing of a steam turbine showing bleed belts

thalpy in Btu per lb; X = heater terminal heat difference, Btu per lb.

Heat given up by extraction steam and condensate from next higher heater is

$$W_1 (h_1 - h_{11}) + W_2 (h_{22} - h_{11}).$$

Equating and solving for q_1

$$q_1 = \frac{(W_e + W_1 + W_2)(h_{11} - X) - W_1 (h_1 - h_{11}) - W_2 (h_{22} - h_{11})}{(W_e + W_1 + W_2)}$$

For the drain cooler, the heat taken up is

$$(W_e + W_1 + W_2)(q_1 - q_c).$$

Heat given up by drip is

$$(W_1 + W_2)(h_{11} - q_d).$$

Equating and solving for q_1

$$q_1 = \frac{(W_e + W_1 + W_2)q_e + (W_1 + W_2)(h_{11} - q_d)}{(W_e + W_1 + W_2)}.$$

Equating values of q_1 and substituting

$$q_c + dh = q_d$$

and solving for W_1

$$W_1 = \frac{W_e (h_{11} - X - q_c) - W_2 [h_{22} - (h_{11} - X) - dh]}{h_1 - (h_{11} - X) - dh}$$

The algebraic analysis of the high-pressure heater, Fig. 3, is

$$W_2 = \frac{W_4 [(h_{22} - X_1) - (h_{11} - X)]}{h_2 - h_{22}}$$

The step-by-step calculation on the form and the worked-out example follow this algebraic solution with every calculation itemized. Those marked *given* or *assumed* pertain to performance of equipment external to the heater or to necessary preliminary data.

Ordinarily, a calculation form can be made up to convenient size with a sufficient number of blank columns for entry of the numerical information pertaining to one or more complete computations. As the calculation progresses, it will be noted that line (13) requires a value from line (35). An estimate of the value of (35) must be made from a preliminary computation as shown and the calculation followed through to obtain a closer approximation. Having the entire calculation on one sheet facilitates inspection of the derived values for reworking the individual steps. The process is repeated until new estimated values of (13) result in no appreciable change in the final value of (35).

This trial-and-error procedure becomes quite convenient after a few trials as the calculator acquires ability to estimate flow quantities closely. However, an algebraic step is possible that gives a direct solution.

Since the steam quantity to the condenser is assumed, the resultant output may differ somewhat from a preconsidered load. Usually a number of calculations are necessary over a load range and the various data can be plotted against output to establish a curve that can then be read at any load.

Experience has shown that even the most complicated heat balance schemes can be successfully worked out in a relatively short time by this method or minor variations of it. It has the advantage of simplicity, and that the actual computation requires only a methodical adherence to a standard form.

ENGINEERS' BOOKSHELF

Air Conditioning

AIR-CONDITIONING PRINCIPLES (1941). *By Charles Osborn Mackey, Professor of Heat Power Engrg, Cornell University. Published by International Textbook Co, Scranton, Pa. 210 pages, 6 x 9 in., charts, tables, problems and answers, flexible binding. Price $2.00.*

This book presents the elementary principles of air conditioning, for students and engineers who have had basic courses in thermodynamics, fluid flow, and heat transfer. Omission of references to equipment and concentration on the theory of the methods used in air conditioning gives this book a high degree of permanence in a field where the practice changes rapidly.

Not only does the author sum up and organize the existing theory of the field; he adds original contributions in the theory of wet-bulb temperature, a new psychrometric formula, application of the "contact-mixture theory" to problems of humidification, dehumidification, heating, and cooling, and data on estimating variable heat flow through sunlit walls.

Patents

PATENT FUNDAMENTALS (1941). *By Leon H Amdur, patent attorney and former patent examiner. Published by Chemical Publishing Co, 148 Lafayette St, New York, N. Y., 305 pages, 5½ x 8½ in., 80 illustrations, cloth binding. Price $4.00.*

Here is a book on patents that the layman and student can readily understand. The author assumes a minimum of initial knowledge of patents on the part of the reader and then proceeds to

(Continued on page 136)

OF course the finest feedwater treatment materials cost Nalco more — Yet Nalco engineers and laboratory technicians are using these materials to prove that *the best is the most economical* in thousands of plants!

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Practical Ways to Clean Heat Exchangers

John M Drabelle gives complete instructions for making, handling, and applying cleaning solutions to boilers, oil coolers, feedwater heaters, and other power-plant heat exchangers[1]

▶ THE MODERN STEAM-POWER PLANT contains a wide assortment of heat exchangers. These include feedwater or stage heaters in which steam at various temperatures and pressures heats water on its way to the boiler; gland-water heaters, blowdown heat exchangers, etc, in which hot water heats cooler water; oil coolers, in which cool water absorbs heat from lubricating oil; and air coolers, in which cool water takes heat from the generator air. Likewise, diesel plants have their share of heat exchangers; water-to-water units for jacket cooling, oil-to-water units for cooling bearing oil and sometimes piston-cooling oil, gas-to-water units for heat recovery, etc.

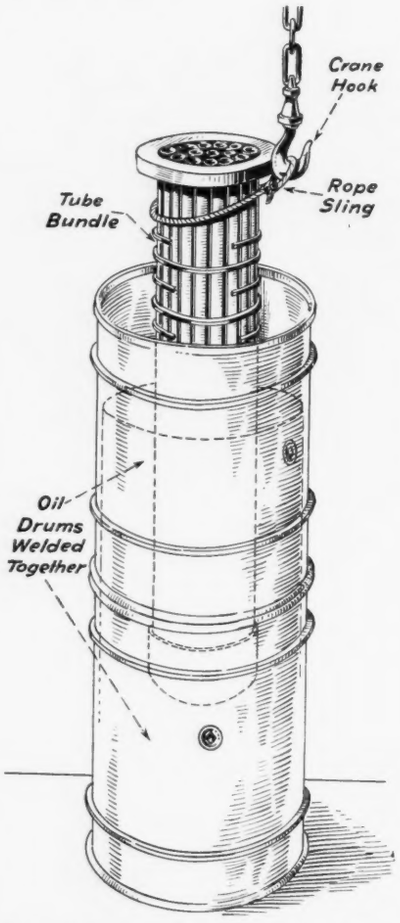
A Tough Cleaning Job

High rates of heat transfer and low terminal differences required make it absolutely necessary to keep these heating surfaces clean, which is easier said than done. Modern boilers with waterwalls and tubes bent to unusual shapes introduce a cleaning problem that is difficult at best with mechanical methods. The extraction feedwater heater, with numerous baffles and hairpin tubes, presents another tough job for mechanical cleaning devices.

For several years past we have been experimenting with various cleaning agents and methods of cleaning for removing slimes on the oil side of lubricating oil coolers, both for steam turbines and for diesel engines. The material called "Oakite", which can be purchased at any grocery store, does an excellent job. The success of its application depends on keeping the solution in motion. This can be accomplished by either a steam or compressed-air jet, and by keeping the solution heated to not less than 160 F.

For convenience, make a cylindrical tank out of two old oil barrels, cutting both heads out of one and then welding the two together, as shown in the sketch.

[1] Based on a talk given before the Missouri Valley Electric Association by Mr Drabelle, consulting engineer for the Iowa Electric Light & Power Co.



Two oil drums, welded together as shown, make a handy solution tank for cleaning heat-exchanger tube bundles

Mix the solution in this tank, lower the tube bundle into the tank by means of the station crane or a chain block, and then turn on the air jet. Better results follow use of two solutions of cleaner, each of moderate strength, rather than attempting to do all the cleaning with one strong solution.

For cleaning water surfaces, on which, in spite of care in water treatment, certain chemicals are deposited, two methods are available. One involves using inhibited muriatic or hydrochloric acid, the other lactic acid, a weak organic acid. Again the rule of solutions of moderate strength applies, and again temperatures of 160–180 F and positive circulation are required. After completing cleaning, carefully wash and flush with clean water and then, as a further precaution, use a weak solution of soda ash (sodium carbonate) to neutralize or kill any remaining acid, followed with another clean-water wash.

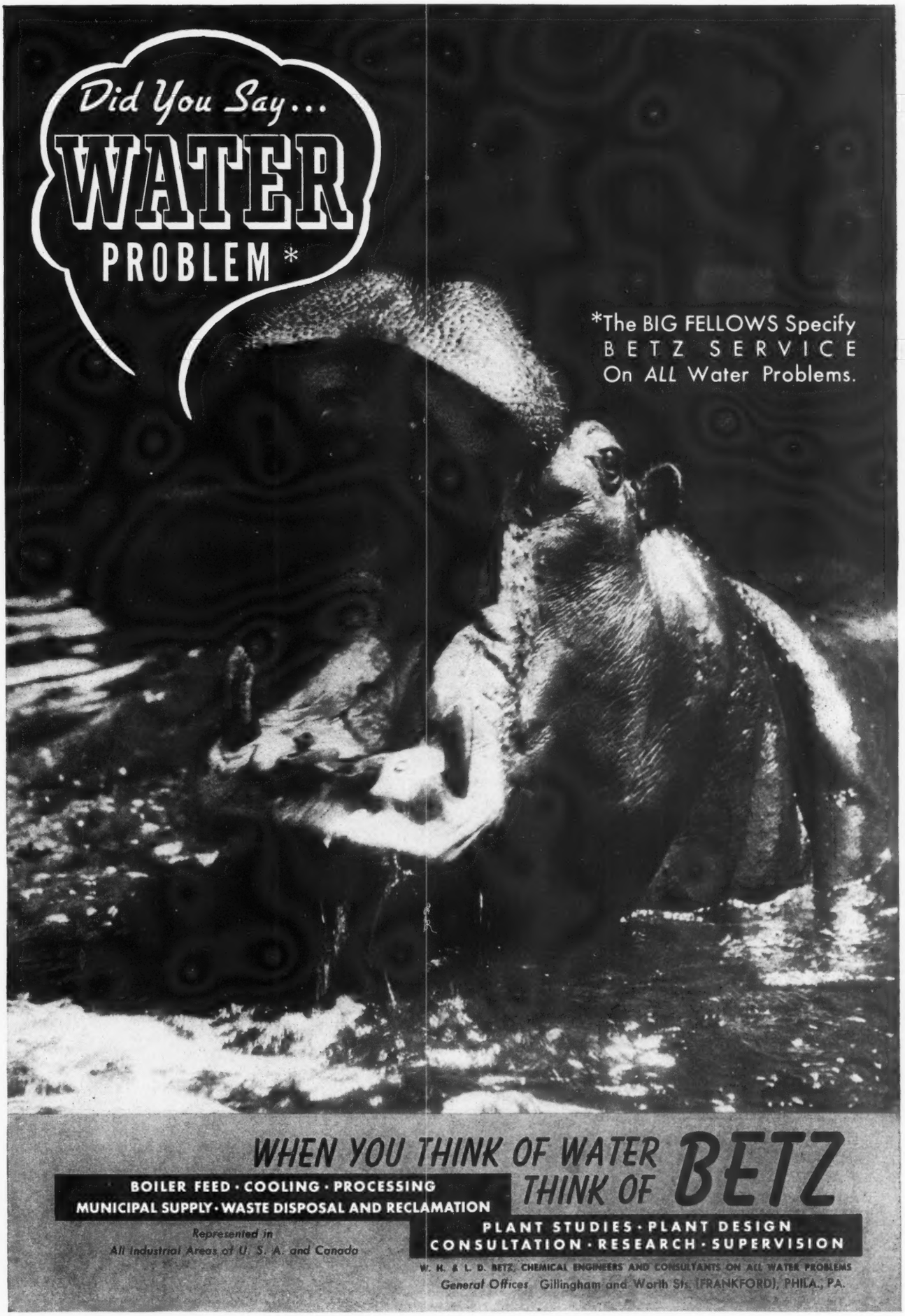
Inhibitors are generally sold under the trade name of a chemical manufacturer. The inhibitor allows the acid to attack scale but prevents it from attacking the metals used in power-station heat exchangers. Inhibited muriatic acid can be bought from chemical houses prepared for use; a typical example is Dearborn Chemical Co's Special Formula 134, which is muriatic acid with a nitrogenous inhibitor.

"Roll Your Own"

Should the engineer desire to make his own solutions, inhibitors can be bought from such companies as Monsanto Chemical Co, and Carbide and Carbon Chemicals Corp. The following specific recommendations for preparing a solution come from the Monsanto Chemical Co. Assuming that 18-deg muriatic acid is purchased, this has a strength of 27.92% hydrochloric acid. To a carboy of acid (11 gal) add one lb of Monsanto "Hibitite", and then dilute to a strength of approximately 2% hydrochloric acid. A 2% solution consists of one gal of 18-deg acid and 15 gal of water. The usual care in handling acids should be observed, such as the use of rubber gloves, goggles and protective rubber apron. Acid should be poured slowly into water; never pour water into acid.

Application of inhibited muriatic acid to equipment cleaning should be handled carefully and in accordance with local conditions. In other words, care and caution should be the rule until sufficient experience has been obtained to work out methods of procedure for the various types of equipment to be cleaned. There are three factors in cleaning: (1) the strength of the

(*Continued on page* 120)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Practical Ways to Clean Heat Exchangers (Continued from page 118)

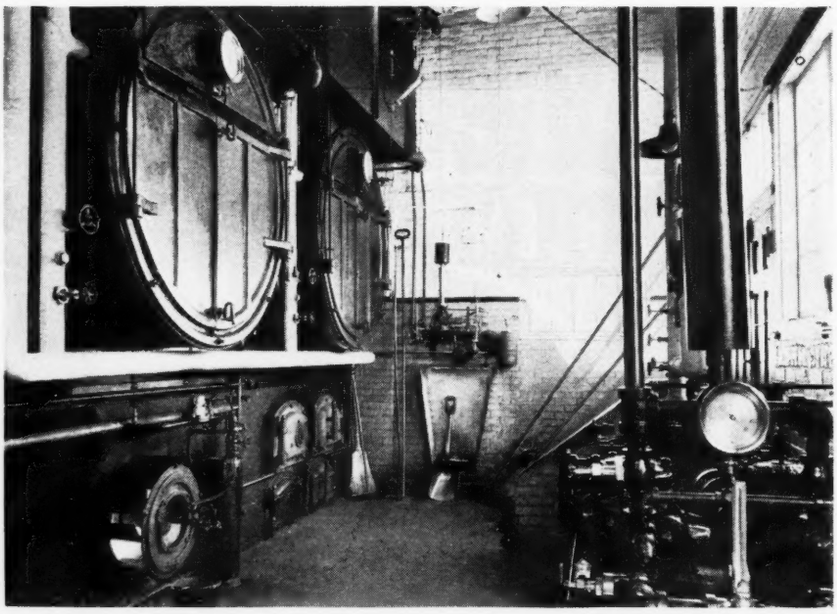
acid, (2) the length of time the acid is allowed to stay in the equipment, and (3) the thickness and kind of scale.

The safest rule seems to be to proceed with a comparatively weak solution applied for a short length of time, say a 2% solution of inhibited hydrochloric acid circulated for a period of 15 minutes. Observe the condition of the deposits on the equipment and see whether it is advisable to increase the strength of the solution, the time of application, or both. Experience definitely dictates use of weaker solutions for a longer period of time rather than strong solutions for a shorter time. Pumped circulation of the acid solution should be used whenever it can be applied, as the scouring action materially assists in the cleaning.

For several years we have experimented with and used solutions of lactic acid for cleaning heat exchangers and, in some cases, hrt boilers. For such work, we buy commercial grade 44% lactic acid from chemical or wholesale drug houses and make up a solution of approximately one gal of acid to 20 gal of water. The application of heat considerably accelerates acid action.

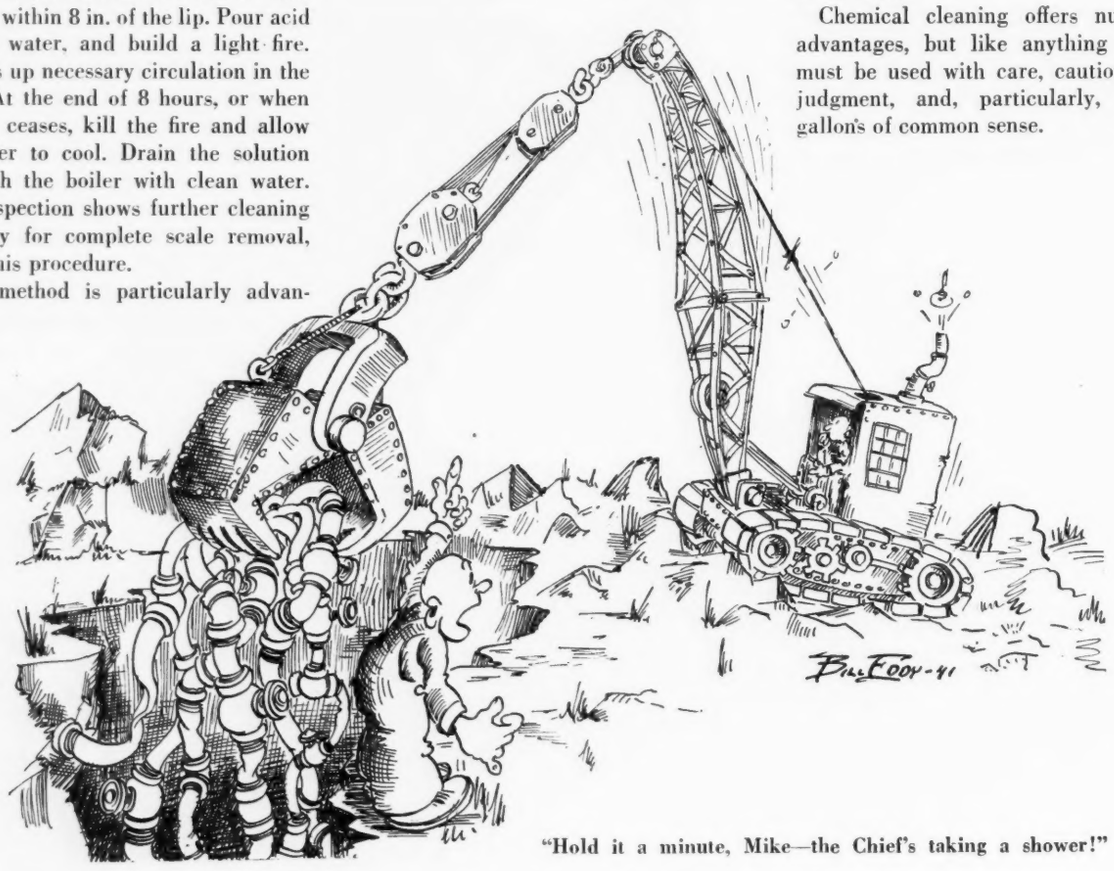
To clean an hrt boiler, remove the manhole head and fill the boiler with water to within 8 in. of the lip. Pour acid into the water, and build a light fire. This sets up necessary circulation in the boiler. At the end of 8 hours, or when foaming ceases, kill the fire and allow the boiler to cool. Drain the solution and flush the boiler with clean water. If an inspection shows further cleaning necessary for complete scale removal, repeat this procedure.

This method is particularly advantageous in removing scale from between the tubes of small boilers where it is difficult and sometimes practically impossible to use mechanical cleaning methods. To kill the acid after the cleaning is complete, fill the boiler with water, add two bucketsful of soda ash, and boil for two hours. This will completely kill or neutralize any remaining acid in any part of the boiler. This same general procedure can be followed for cleaning heat exchangers and similar devices.

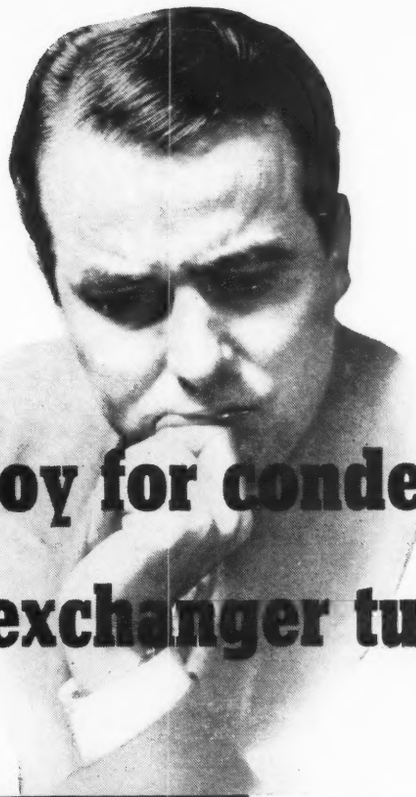


Experience shows lactic-acid solutions effective in cleaning horizontal tubular boilers

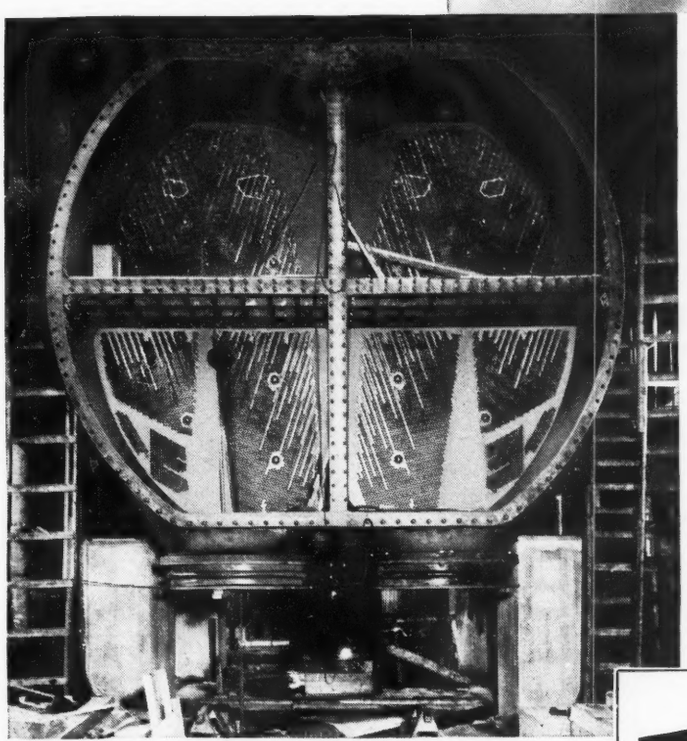
Chemical cleaning offers numerous advantages, but like anything else it must be used with care, caution, good judgment, and, particularly, several gallons of common sense.



"Hold it a minute, Mike—the Chief's taking a shower!"



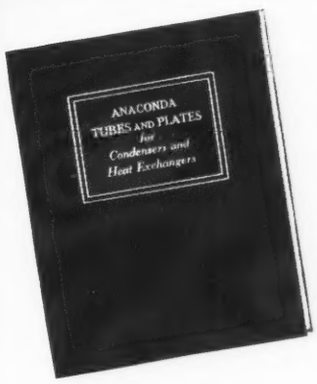
What alloy for condenser and heat exchanger tubes ?



Perhaps the problem is not as involved as it seems

There are factors in condenser operation that are often as important in their influence upon tube life as the character of the cooling water. Such factors may be turbulent flow, excessive local velocities or entrained air. They should be considered in selecting a condenser tube alloy.

The engineers of our Technical Department have devoted years not only to the metallurgy of tube alloys, but to the study of the complex conditions under which condenser and heat exchanger tubes must serve. Their suggestions have helped many tube users. Perhaps they can help you to arrive at a logical solution of *your* problems.



The American Brass Company manufactures a wide range of tube alloys for condenser and heat exchanger installations. They are fully described in our latest Condenser Tube Publication B-2, which will be sent upon request.

41112

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Gas-Engine Test Data Gets Fine-Tooth-Comb Inspection

▶ In July, 1940, (pgs 444, 445), Power published test data and results of operation at Rea Station. Louisiana Ice & Electric Co, Bunkie, La., reported to be the largest gas-engine central station. The published figures, which showed exceptional performance, drew an extended critical analysis from a reader, Albert Cross.

To establish the facts, Power sent a copy of the comments to F H Coughlin, vice-president, Louisiana Ice & Electric Co, under whose general direction the tests were made. He, in turn, transmitted the criticisms to B S Nelson, chief engineer, A M Lockett & Co, who installed the plant, and to H P Yount, engine test inspector, Worthington Pump and Machinery Co. Mr Nelson is well known in the Southwest as one of its outstanding engineers. Mr Yount has had wide experience in engine testing; his reply to the critical comments is concurred in by H C Lehn, consulting engineer for Worthington.

Mr Nelson and Mr Yount arrived at substantially the same conclusions, independently. For the sake of clarity, Mr Cross' original comments have been broken into individual items, and the appropriate parts of the replies from Messrs Coughlin, Nelson, and Yount follow immediately. Where the replies are substantially the same, only one is given. All the following material is direct quotation; the names in parentheses indicate the authors. For reference, the table of test data appearing in the original article is reprinted here.

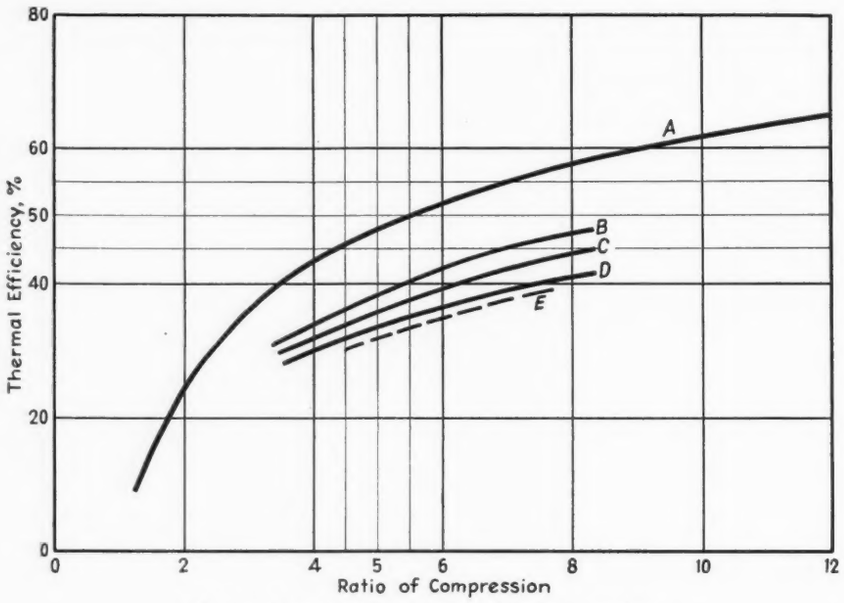
(Cross): *"As a first step in the examination of these tests, let it be stated quite definitely that tests on internal-combustion engines are always based on high heat value."*

(Nelson): "The statement that tests on internal-combustion engines are always based on high heat value is incorrect. Worthington is the largest and oldest builder of large gas engines in the United States and their fuel guarantees are made on the low heating value. I attach copy of the manufacturers' actual guarantees on these particular engines where you will note the printed guarantee form clearly states and interprets low heat value. I am told this is standard practice with other large gas-engine manufacturers also."

TABLE I—ABSTRACT OF TEST DATA—REA STATION

Louisiana Ice & Electric Co, Bunkie, La.

	Engine G-909-90					
	122.5%	110%	100%	75%	50%	0%
Duration	6 min	2 hr	12 hr	20 min	6 min	5 min
Indicated kw	1,225	1,104	1,003	733	578	0
Generator efficiency	95.25	95.20	95.10	94.65	94.15	.....
Brake horsepower	1,725	1,620	1,427	1,040	823	.....
Corrected cu ft gas per hr	12,750	11,770	11,170	8,670	7,680	4,430
Higher heating value of gas	1149 Btu/cu ft.		Net value = 1044 Btu/cu ft			
Millions of Btu per hr, net	13.32	12.30	11.67	9.05	8.02	4.62
Net Btu per kwhr	10,870	10,690	11,530	12,340	13,860	.....
Net Btu per brake hphr	7,720	7,590	8,170	8,700	9,730	.....
Engine thermal efficiency, %	33.0	33.5	31.2	29.3	26.1	.....
Unit over-all thermal eff, %	31.4	31.9	29.6	27.7	24.6	.....
Engine rpm	225	225	225.5	225	225	225
Exhaust temp, No. 7 cyl, F	.....	912	928	850	825	.....
Exhaust temp, right line, F	.....	852	869	800	780	.....
Exhaust temp, left line, F	.....	785	813	725	700	.....
Water temp into engine	121	121	116	121	121	120
Water temp from heads	132	135	130	132	132	131
Water temp from engine	136	143	137	140	136	135
Lube-oil temp from engine	127	127	124	127	127	127



Ideal and actual efficiencies of Otto-cycle engines

(Yount): "The use of the net value for these tests was, of course, fully understood by all parties concerned, and is comparable to the guarantees, which are also based on the net value. This is plainly indicated in the printed article in so many places that it is hard to see how the intent could be distorted.

"True comparisons of performance of equipment with various gases requires consideration of the net heat value because very seldom does the latent heat value from the water formed during combustion become available in useful work. Making guarantees on the net value automatically provides such consideration.

"The argument has been advanced that, in most gases, the ratio of net to high value is nearly 90% so that comparative data would not be in error if the high value were used universally. This would not be true, for instance, in a change from carburetted water gas to a coal gas of the same nominal value,

(*Continued on page 200*)

. . TO GOOD VALVE *PRACTICE* . .

FOR H.P. PROCESS SYSTEMS . . .

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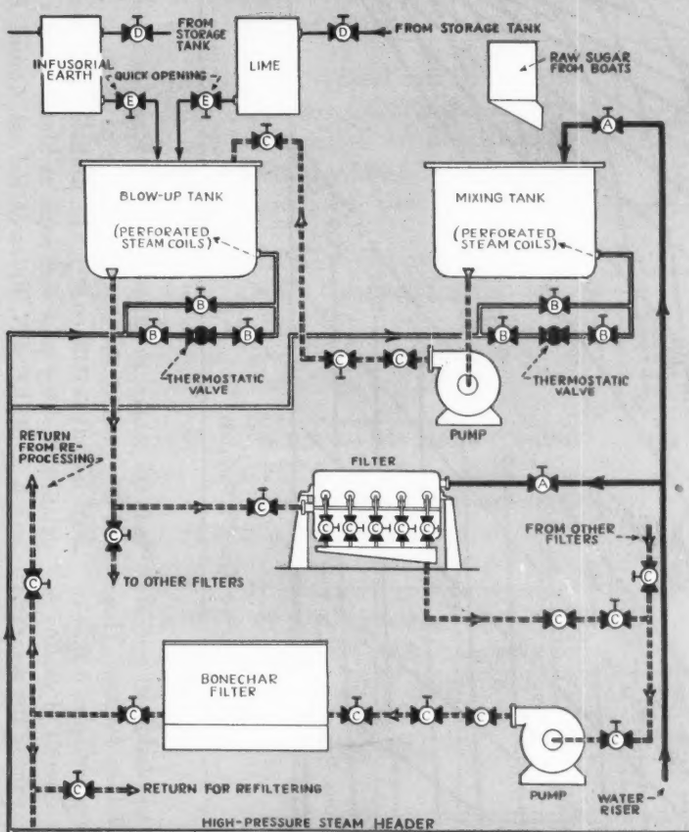
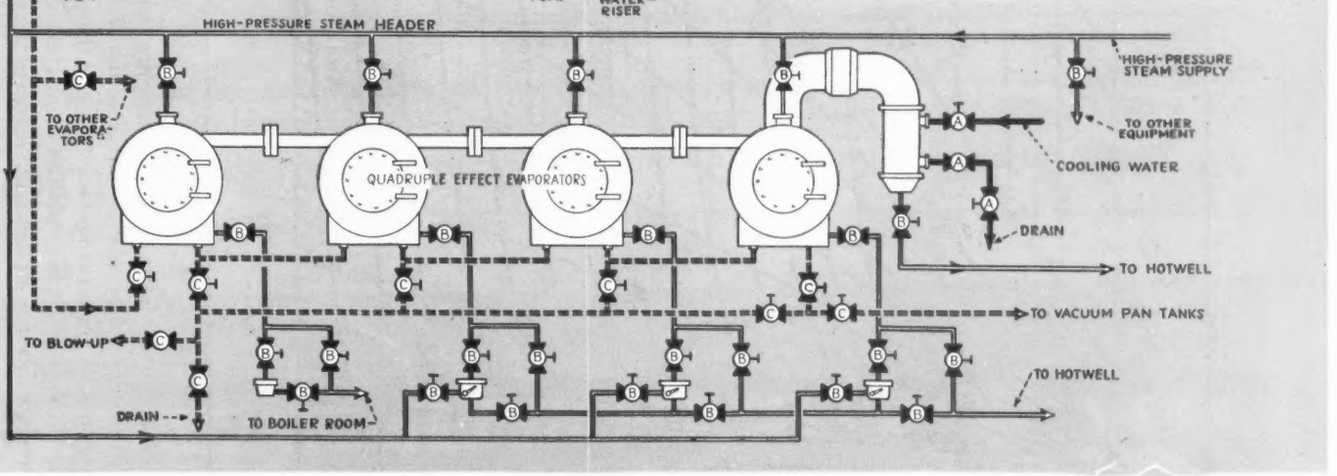
SUGAR REFINERY PIPING





REFERENCE CHART FOR JENKINS FIGURE NUMBERS

		Standard	Medium	Extra Heavy
A	WATER LINES GATE	IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S.& Y. 651 Fl. O.S.& Y.	IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	SWING CHECK	IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	IRON 338 Sc. Disc Type 339 Fl. Disc Type	IRON 338 Sc. Disc Type 339 Fl. Disc Type
B	STEAM LINES GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew IRON 922 Sc. Regrinding 923 Fl. Regrinding 182A Sc. Disc Type 162 Fl. Disc Type
	GATE	BRONZE 47 Sc. Travel Spindle 49 Sc. Travel Spindle 370 Sc. Non-Rising 368 Sc. O.S.& Y. 670 Sc. Non-Rising 672 Sc. O.S.& Y. 674A Sc. Non-Rising 675A Fl. Non-Rising 676A Sc. O.S. & Y. 677A Fl. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type IRON 338 Sc. Disc Type 339 Fl. Disc Type
	HORIZONTAL LIFT CHECK	BRONZE 117A Sc. Disc Type IRON 151 Sc. Disc Type 153 Fl. Disc Type 928 Sc. Regrinding 929 Fl. Regrinding	BRONZE 756 Sc. Regrinding 807 Sc. Disc Type IRON 151 Sc. Disc Type 153 Fl. Disc Type 928 Sc. Regrinding 929 Fl. Regrinding	BRONZE 263 Sc. Disc Type 966 Sc. Regr.-Renew IRON 265 Sc. Disc Type 266 Fl. Disc Type 934 Sc. Regrinding 935 Fl. Regrinding
C	SUGAR SOLUTION GLOBE	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above
	GATE	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above
	SWING CHECK	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above
	"Y" VALVE	BRONZE 124 Sc. Disc Type 125 Fl. Disc Type IRON 296 Sc. Disc Type 297 Fl. Disc Type	BRONZE 134 Sc. Disc Type 135 Fl. Disc Type IRON 336 Sc. Disc Type 337 Sc. Disc Type	BRONZE 134 Sc. Disc Type 135 Fl. Disc Type IRON 336 Sc. Disc Type 337 Sc. Disc Type
D	CO_2 LINES GLOBE	BRONZE Same as "B" above	BRONZE Same as "B" above	BRONZE Same as "B" above
E	CHEMICAL FEED LINES GLOBE	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above	BRONZE & IRON Same as "B" above
F	QUICK OPENING GLOBE	BRONZE 720 Sc. Lever Type 712 Sc. Lever Type		
	GATE	BRONZE 376 Sc. Stld. Spindle and Lever IRON 334 Sc. Stld. Spindle and Lever 335 Fl. Stld. Spindle and Lever		

Motor-operated Iron and Steel Valves can be supplied.

NEXT MONTH: INDUSTRIAL "TOPPING" PLANT

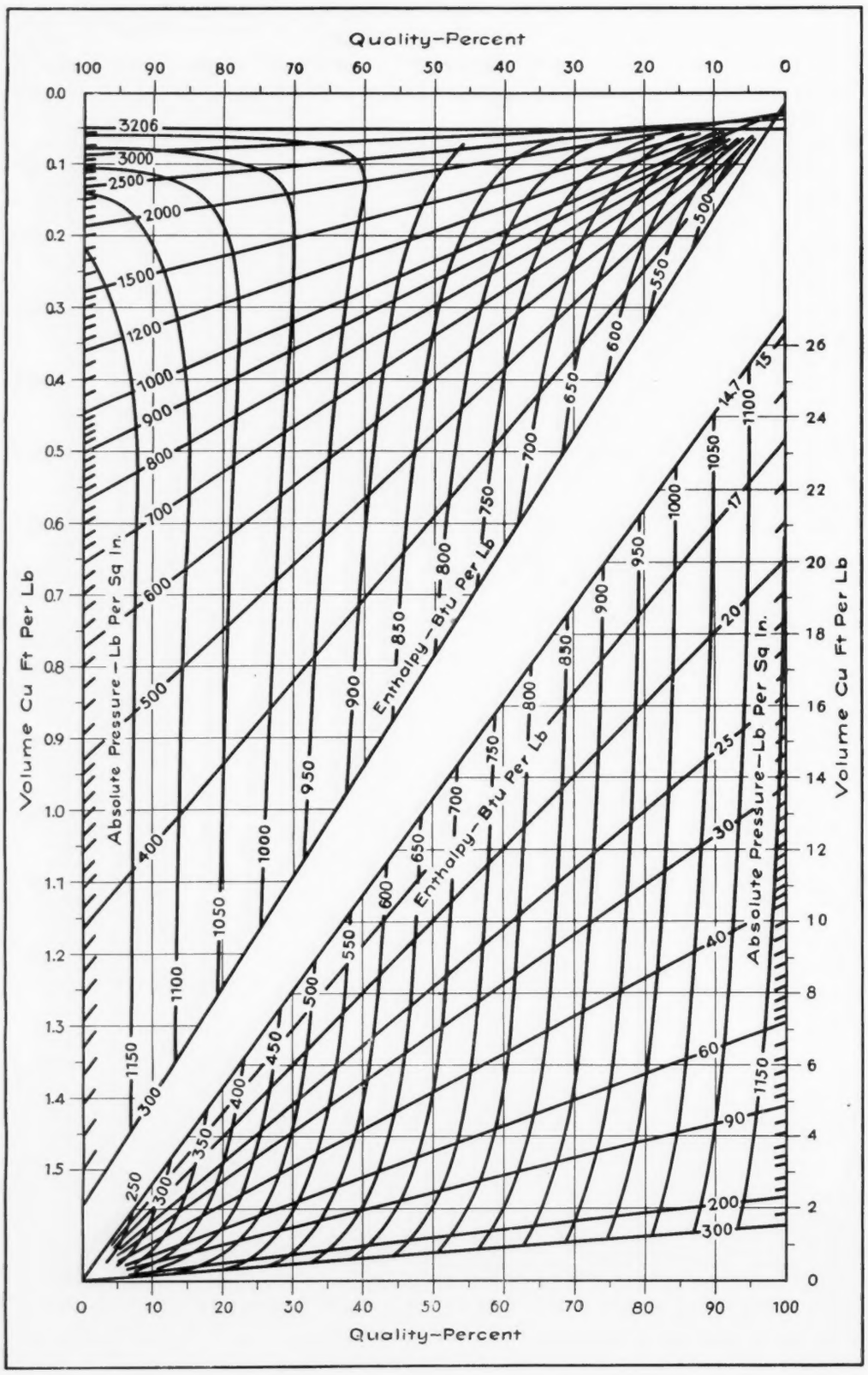
#30 OF A SERIES designed to help in your selection of **JENKINS VALVES**

Prompt delivery of Jenkins Valves from reliable supply houses everywhere

JENKINS BROS., TRADE JENKINS MARK REG. U.S. PAT. OFF. Jenkins Bros. BRIDGEPORT, CONN.

Number 107

Volume-Quality Chart for Steam



BOILER CIRCULATION studies frequently require calculation of specific volume of wet mixtures beyond the range of the Mollier diagram. These two charts, one for pressures up to 300 lb and the other from 300 lb to critical pressure give specific volumes of mixture directly if quality is known. Pressure lines are straight, and marks at the edge of the diagrams indicate where to place a straightedge for accurate estimation.

For example, the specific volume of steam at 2500-lb pressure and 50% quality is 0.08 cu ft per lb. Enthalpy lines are shown to permit calculating flashing processes such as blowdown. By C G HUMPHREYS *and* A A MARKSON, *Research Bureau, Consol. Edison Co of N. Y.*

© POWER

1941 REPEAT ORDERS

120 POUNDS W.S.P.—Steel company orders a third COPES Flowmatic for installation on a Freyn waste-heat boiler with capacity of 25,000 pounds per hour. *A Flowmatic user since 1937.*

165 POUNDS W.S.P.—Rolling mill orders a second COPES Flowmatic for installation on a Babcock & Wilcox boiler with capacity of 50,000 pounds per hour. *A Flowmatic user since 1939.*

175 POUNDS W.S.P.—Steel company places its sixth order for COPES Flowmatics. Two will be installed on Badenhausen boilers evaporating 125,000 pounds per hour. *A Flowmatic user since 1938.*

200 POUNDS W.S.P.—Steel company orders its fifth COPES Flowmatic for installation on an Erie City boiler having capacity of 100,000 pounds per hour. *A Flowmatic user since 1940.*

390 POUNDS W.S.P.—Oil refiner orders ninth COPES Flowmatic. Installation will be on a waste-heat boiler evaporating 72,000 pounds per hour. *A Flowmatic user since 1937.*

405 POUNDS W.S.P.—Eastern navy yard orders a second COPES Flowmatic for installation on a Riley boiler with capacity of 165,000 pounds an hour. *A Flowmatic user since 1940.*

420 POUNDS W.S.P.—Chemical company orders its sixth COPES Flowmatic. To be installed on a Riley boiler evaporating 300,000 pounds an hour. *A Flowmatic user since 1938.*

600 POUNDS W.S.P.—Synthetic textile producer orders sixth COPES Flowmatic. To be installed on a Riley boiler evaporating 300,000 pounds per hour. *A Flowmatic user since 1937.*

725 POUNDS W.S.P.—Munitions manufacturer orders third COPES Flowmatic for installation on a Riley boiler having capacity of 125,000 pounds per hour. *A Flowmatic user since 1937.*

865 POUNDS W.S.P.—Utility orders its sixth COPES Flowmatic for installation on a Babcock & Wilcox boiler evaporating up to 433,000 pounds per hour. *A Flowmatic user since 1940.*

900 POUNDS W.S.P.—Utility orders its second COPES Flowmatic. To be installed on a Riley boiler with capacitity of 300,000 pounds per hour. *A Flowmatic user since 1940.*

These eleven users have installed or on order a total of 53 COPES Flowmatic Regulators.

If you want to get new boilers more quickly on the line . . . if you want absolutely dependable control of your boiler water level . . . specify the COPES Flowmatic. Write for descriptive Bulletin 429.

NORTHERN EQUIPMENT COMPANY, 611 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

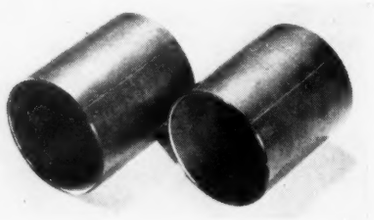
WHAT'S NEW IN PLANT EQUIPMENT

Lubricating Oil

"HPO" LUBRICATING OIL developed after intensive laboratory and field tests, and announced as company observed Diamond Jubilee, 75 years after introduction of first mineral lubricating oil for steam engines. To lubricate, seal, clean and cool modern high-speed engines effectively, two factors were combined in new lubricant. First is high viscosity index (105-110), highest of any heavy-duty oil on market, and second is effective detergent agent. In this Pennsylvania oil, detergent acts with oil as soap does with water. It keeps undesirable oxidation particles circulating with oil and prevents them from depositing in engine. Detergent action results in "dirtier" oil, according to maker, but does not cut down lubricating qualities. *Valvoline Oil Co, 5th & Butler Sts, Cincinnati, Ohio.*

Bronze-on-Steel Pre-Cast Bearing

Bronze-on-steel is essentially thin-wall laminated bearing that combines bearing qualities of high-grade bronze alloy with strength of steel. Using SAE 64, made up of 80% copper, 10% tin and 10% lead, alloy is cast in solid bronze bars, uniting metals chemically and forming definite copper-tin eutectic, with lead trapped in insterstices. Next center of each casting is removed by drilling. Borings thus obtained are reduced to a powder, treated



in hydrogen furnace to remove all oxides, then firmly bonded to strip steel. Precast bearing also available as graphited bearing. Graphite is added by different method, during which it is thoroughly mixed with bearing powder before bonding operation. This gives even distribution throughout entire bearing area, and graphite becomes an integral part of bearing, unaffected by oil, gasoline or water, according to maker. *Johnson Bronze, 508 S Mill St, New Castle, Pa.*

Fire Extinguisher

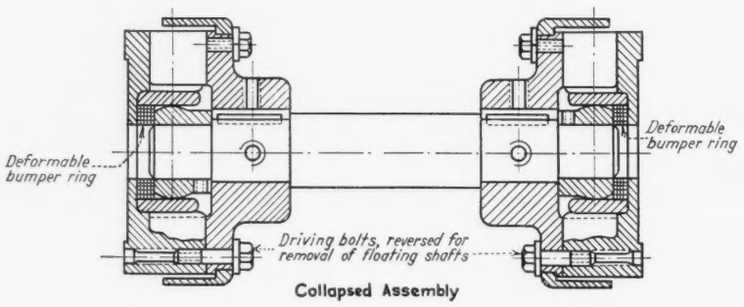
EXTINGUISHING AGENT puts out magnesium fires and fires resulting from incendiary bombs. Known as Pyrene G-1 Fire Extinguishing Powder, new substance is result of combined research by Dow Chemical Co and Pyrene Mfg Co. Product is dry inert compound that stops combustion of magnesium as well as other metals such as sodium, potassium, aluminum and zinc. Also contains material, which when heated, forms heavy, air-excluding, fire-smothering vapor. Powder is applied to fire by spreading it with scoop or shovel, and being nonabrasive, can be used freely around machinery. *Pyrene Mfg Co, 560 Belmont Ave, Newark, N. J.*

Patching Compound

FLOOR-PATCH is not tar or asphalt, or portland cement product, but cementitious material for patching floors. Adaptable to quick, overnight repairs, as floors may be used for light traffic next morning. The maker claims that it eventually sets harder than concrete itself. *Truscon Labs, Detroit, Mich.*

Butterfly Valve

ILLUSTRATED IS HAND-WHEEL-OPERATED design of company's improved butterfly valve in which internal parts are machined to assist operation and obtain tight fit between housing and vane. Line includes standard range of sizes from 2 to 48 in., for working pressures up to 15 lb. Feature in design lies in pair of adjustable stops provided to stop vane in either of two set positions between open and closed. This permits constant duplication of any set maximum or opening, in addition to full-open and tight-closed positions. All valves have graduated dial and pointer for exterior determination of butterfly vane. *R-S Products Corp, 4530 Germantown Ave, Philadelphia, Pa.*



Collapsed Assembly

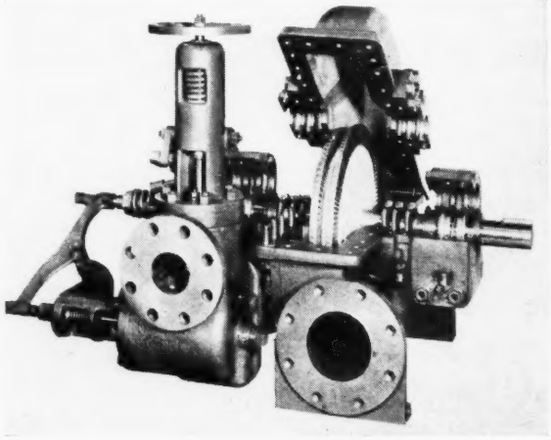
Flexible Coupling (Above)

L-R TYPE HKQ is applicable to either horizontal or vertical drives, and is recommended for longer-distance drives where space between drive and driven units cannot be handled successfully by standard couplings, and especially where there is excessive misalignment. As illustration shows, floating shaft is supported in fixed bearings, entirely independent of power-transmitting elements, and does nothing but transmit useful power. Unit can be dis-assembled quickly, operation merely requiring reversal of 3 to 5 driving bolts. Chatter caused by end-wise impact of floating shaft against fixed shaft is prevented by deformable-bumper-ring cushions. *Lovejoy Flexible Coupling Co, 5009 West Lake St, Chicago, Ill.*

Safety Control

COMBINED TRIP AND THROTTLE VALVE has been designed and built into Type D mechanical-drive turbine built by company. Provides overspeed protection similar to that on large central-station and industrial units. Type D units rated from 5 to 2000 hp in speeds from 1000 to 5000 rpm. Positive protection assured because built-in valve shuts off all steam flow automatically before dangerous speed is reached. Easily accessible Monel-metal, basket-type steam strainer around trip and throttle valve prevents foreign material from entering. *General Electric Co, Schenectady, N. Y.*

(Continued on page 168)



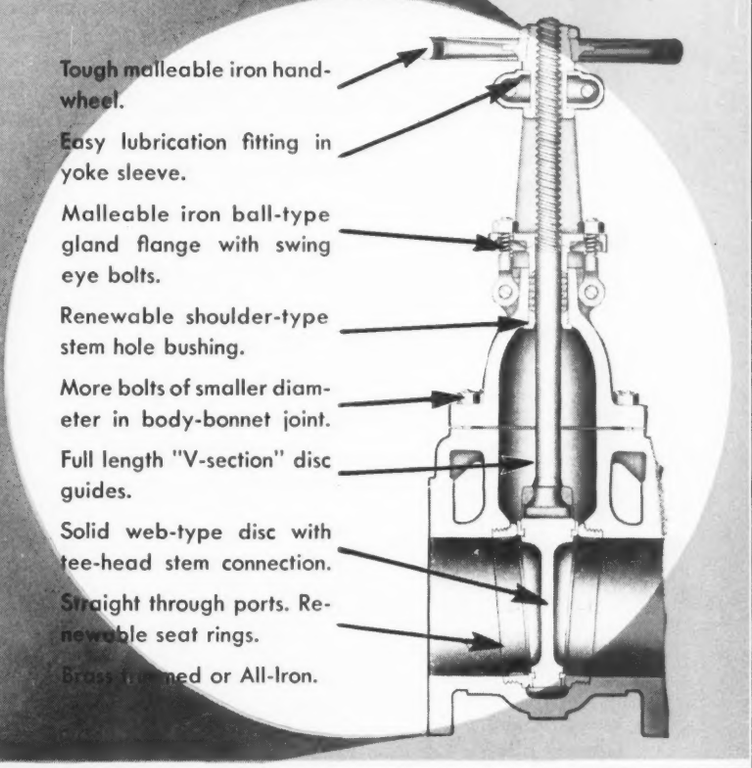
A NEW, IMPROVED LINE OF IRON BODY WEDGE GATE VALVES

FOR 125 POUNDS STEAM, 200 POUNDS COLD WATER, OIL OR GAS

Advanced design throughout these valves increases adaptability for service and minimizes maintenance in severest usage. Made in all types: Non-Rising Stem . . . Outside Screw and Yoke . . . Quick-Opening . . . Underwriters' Patterns . . . Marine Cargo Oil System Valves. Also in Alloy Cast Iron. Flanged, screwed, or hub ends.

Catalog giving complete specifications on the entire line is available from your Crane Representative or by mail request.

NEW FEATURES LIKE THESE IN ALL PATTERNS


Tough malleable iron hand-wheel.
Easy lubrication fitting in yoke sleeve.
Malleable iron ball-type gland flange with swing eye bolts.
Renewable shoulder-type stem hole bushing.
More bolts of smaller diameter in body-bonnet joint.
Full length "V-section" disc guides.
Solid web-type disc with tee-head stem connection.
Straight through ports. Renewable seat rings.
ned or All-Iron.

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836 S. MICHIGAN AVE., CHICAGO

VALVES • FITTINGS • PIPE • PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

POWER LINES

J H Collier Is New Crane President

John H Collier was elected president of the Crane Co, Chicago, at a special meeting of the board of directors held May 5. He fills the vacancy created by the sudden death of Charles B Nolte on April 29.

Mr Collier is a graduate of Purdue University, and joined the Crane organization upon leaving school, in

John Collier

1903. From his original position as core maker's helper he has progressed through a variety of positions, the more important of which are general manager, Bridgeport, Conn., plant, 1917-1929; president Cie Crane, Paris, France, and chairman, Crane, Ltd, London, England, 1929-1933; vice president in charge of manufacturing, Crane Co, Chicago, 1933-1941.

P H Gotschall Heads Spy Run Station

Paul H Gotschall, efficiency engineer for the past 10 years at the Spy Run Generating Station of the Indiana Service Corp, was appointed superintendent of power production, succeeding W S Richhart, who passed away recently.

A native of Indiana, Mr Gotschall was graduated from Purdue University in 1920. He was employed as a small motors engineer at Fort Wayne Works, General Electric Co, from 1920 to 1922, at which time he became associated with Indiana Service Corp as construction engineer in electrical operating department. In 1930 he was named efficiency engineer in the power plant, a post he held until his appointment.

P H Gotschall

Mr Gotschall is an active member of the Fort Wayne Engineers Club and of the National Association of Power Engineers. In his new capacity, he will be in charge of all electric generation for the utility company, serving under S W Winje, superintendent of electrical operations.

PERSONALS

JOHN A GRAHAM was recently elected honorary chairman of the board, Purolator Products, Inc, Newark, N. J., and Ralph R Layte was made president of the company. Mr Graham was associated with American Simplex, Houdaille and Studebaker Corp, and since 1925 has been president of Purolator Products, Inc, formerly Motor Improvements, Inc.

CARL J ANDRAE has been made assistant sales manager of Replacement Div, Wilkening Mfg Co, Philadelphia, Pa. He is widely known in the field, having

Carl Andrae

been associated with Perfect Circle Co, for a number of years, as district manager, and for the past three years with the Hastings Mfg Co, as regional manager.

B J BRUGGE has been appointed welding consultant to Lincoln Electric Co, Cleveland, Ohio, at Washington, D. C. He will be engaged in consulting work and will be associated with T C Canty, Inc, Lincoln representatives in Washington.

B J Brugge

JAMES COOMBE has been elected president of The Wm Powell Co, manufacturers of bronze, iron, steel and corrosion resistant valves. With the exception of two and a half years, during which he served over-seas as an artillery captain in the first World War, he has been associated with the company since his graduation from Yale in 1910. Mr. Coombe is also a director of the Crosley Corp, the

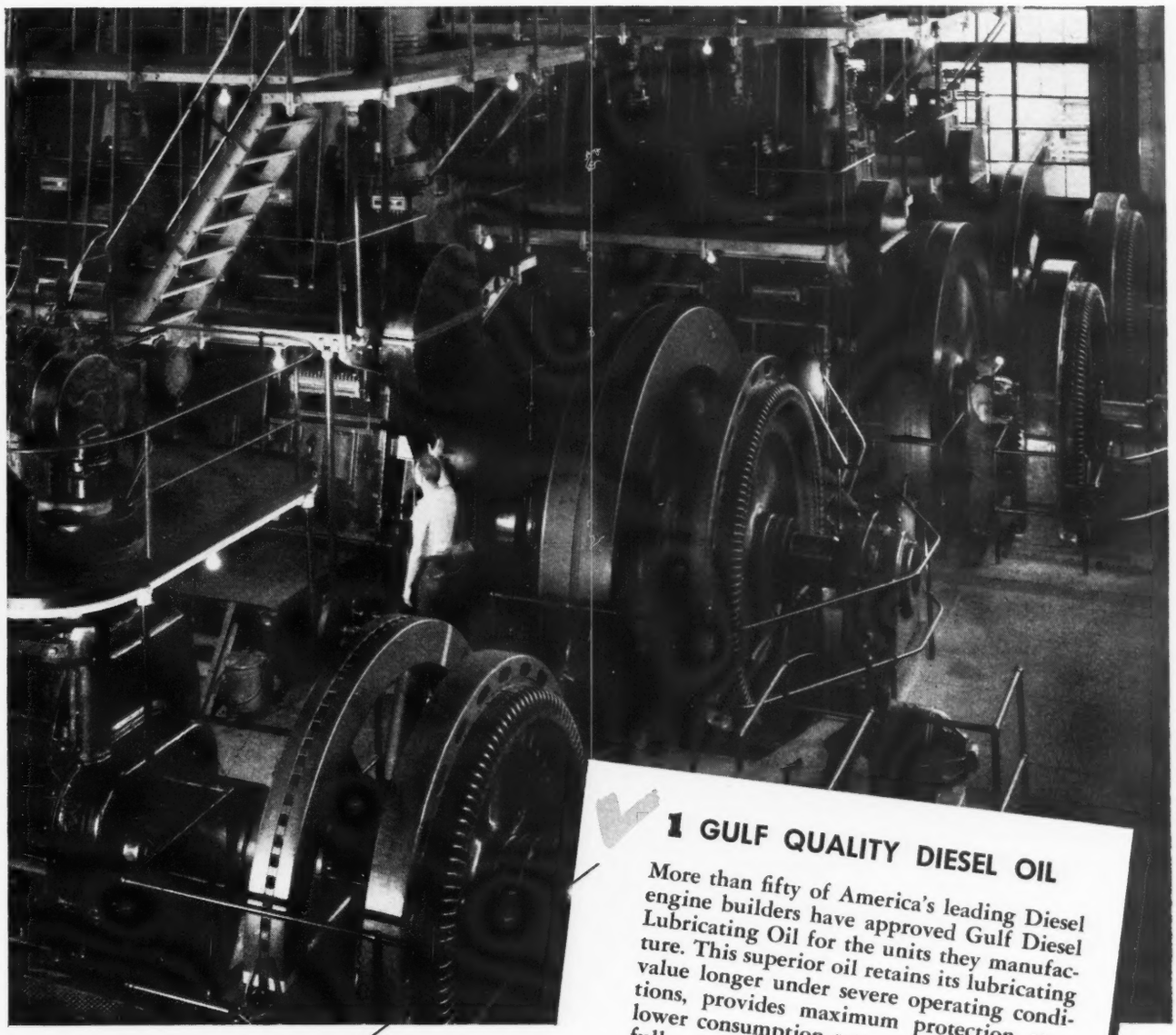
James Coombe

Globe-Wernicke Co, and the Randall Corp.

The Wm Powell Co announced also the election of Harry H. Coombe, chairman of the board of directors and treasurer; George E Weitkamp, first vice-president and secretary; David M Forker, Oliver F Gang, Wm E Heilig and E R Noll, vice-presidents; and Wm E Minor, Jr, assistant to the president.

LEON S JACKSON, sales representative of the Linde Air Products Co, Boston.

(Continued on page 146)



GULF CONTRIBUTIONS to more efficient Diesel Operation

1 GULF QUALITY DIESEL OIL

More than fifty of America's leading Diesel engine builders have approved Gulf Diesel Lubricating Oil for the units they manufacture. This superior oil retains its lubricating value longer under severe operating conditions, provides maximum protection at a lower consumption rate, and contributes to full power and operating efficiency.

2 GULF PERIODIC CONSULTATION SERVICE

Gulf offers the services of trained lubrication engineers to both builders and operators of Diesel engines. Gulf engineers have broad experience with all types of Diesels and can give worth-while suggestions which help increase engine efficiency and keep maintenance costs at a minimum.

3 GULF RESEARCH

A large staff of qualified technologists in Gulf research laboratories is constantly engaged in exhaustive research to add fresh knowledge of Diesel engines and lubricants to Gulf's vast fund of information—gained through 37 years of active experience.

GULF INDUSTRIAL LUBRICATION

GULF OIL CORPORATION · GULF REFINING COMPANY · PITTSBURGH, PA.

Flag Day . . .

What's a flag? What's the love of country for which it stands? Maybe it begins with love of the land itself. It is the fog rolling in with the tide at Eastport, or through the Golden Gate and among the towers of the Green, throwing a shining glory on Lake Champlain and above the Adirondacks. It is the storied Mississippi rolling swift and muddy past St. Louis, rolling past Cairo, pouring down past the levees of New Orleans. It is lazy noon-tide in the pines of Carolina, it is a sea of wheat rippling in Western Kansas, it is the San Francisco peaks far north across the glowing nakedness of Arizona, it is the Grand Canyon and a little stream coming down out of a New England ridge, in which are trout.

It is men at work. It is the storm-tossed fishermen coming into Gloucester and Provincetown and Astoria. It is the farmer riding his great machine in the dust of harvest, the dairyman going to the barn before sunrise, the lineman mending the broken wire, the miner drilling for the blast. It is the servants of fire in the murky splendor of Pittsburgh, between the Allegheny and the Monongahela, the trucks rumbling through the night, the locomotive engineer bringing the train in on time, the pilot in the clouds, the riveter running along the beam a hundred feet in air. It is the clerk in the office, the housewife doing the dishes and sending the children off to school. It is the teacher, doctor and parson tending and helping, body and soul, for small reward.

It is the small things remembered, the little corners of the land, the houses, the people that each one loves. We love our country because there was a little tree on a hill, and grass thereon, and a sweet valley below; because the hurdy-gurdy man came along a sunny morning in a city street; because a beach or a farm or a lane or a house that might not seem much to others were once, for each of us, made magic. It is voices that are remembered only, no longer heard. It is parents, friends, the lazy chat of street and store and office, and the ease of mind that makes life tranquil. It is Summer and Winter, rain and sun and storm. These are flesh of our flesh, bone of our bone, blood of our blood, a lasting part of what we are, each of us and all of us together.

It is the stories told. It is the Pilgrims dying in their first dreadful winter. It is the minute man standing his ground at Concord Bridge, and dying there. It is the army in rags, sick, freezing, starving at Valley Forge. It is the wagons and the men on foot going westward over Cumberland Gap, floating down the great rivers, rolling over the great plains. It is the settler hacking fiercely at the primeval forest on his new, his own lands. It is Thoreau at Walden Pond, Lincoln at Cooper Union, and Lee riding home from Appomattox. It is corruption and disgrace, answered always by men who would not let their flag lie in the dust, who have stood up in every generation to fight for the old ideals and the old rights, at risk of ruin or of life itself.

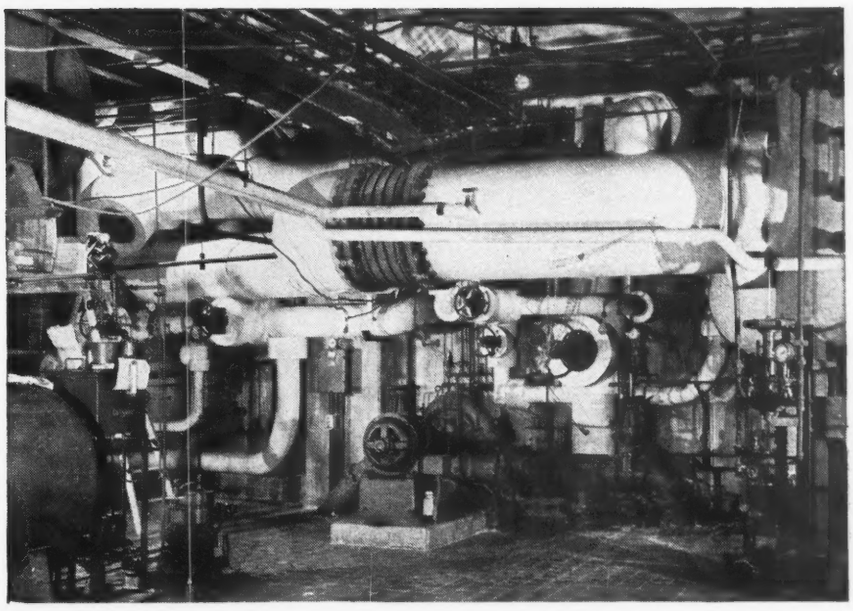
It is a great multitude of people on pilgrimage, common and ordinary people, charged with the usual human failings, yet filled with such a hope as never caught the imaginations and the hearts of any nation on earth before. The hope of liberty. The hope of justice. The hope of a land, in which a man can stand straight, without fear, without rancor.

The land and the people and the flag—the land a continent, the people of every race, the flag a symbol of what humanity may aspire to when the wars are over and the barriers are down; to these each generation must be dedicated and consecrated anew, to defend with life itself, if need be, but, above all, in friendliness, in hope, in courage, to *live* for.

June 14, 1940, The New York Times published this editorial. I've been carrying it in my wallet ever since — and I thought you might want a copy too. It's more pertinent now even than it was a year ago.

George Edwards
Engineer

DOES YOUR INSULATION INVESTMENT PAY A *FULL* RETURN?



On Furnaces where insulation is required to resist temperatures up to 1900° F., J-M Superex is widely recognized as the most efficient block insulation available today. Hundreds of installations under all types of operating conditions prove its long life and low maintenance.

For Temperatures Up To 600° F., you save by using J-M 85% Magnesia. For years the standard material for insulating power-plant equipment and steam lines, it combines light weight with permanently high insulating efficiency.

HOW much money you spend on fuel depends to a large extent on the answers to these two questions:

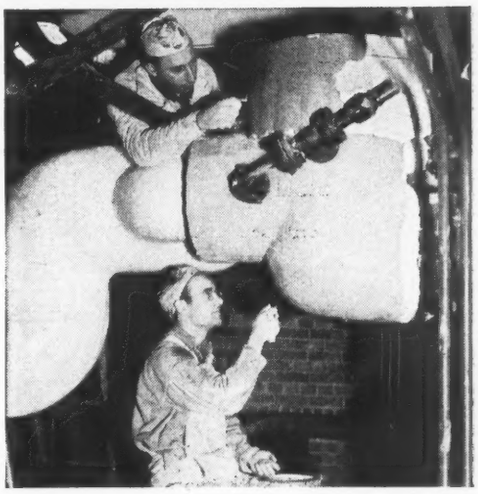
Are you using the *correct insulating materials?*

Are they applied in the *correct thicknesses?*

To assure every saving possible with insulation, it will pay you to call in a J-M Insulation Engineer. Let him study your requirements . . . his specialized technical training and experience will help you trace down and correct sources of heat waste that may otherwise go unnoticed.

From the complete line of J-M Insulations, he can recommend exactly the *material* you need for greatest efficiency . . . exactly the *thickness* you need for maximum returns.

For full details on this helpful service and facts about the complete line of J-M Industrial Insulations, write to Johns-Manville, 22 East 40th Street, New York, N. Y.

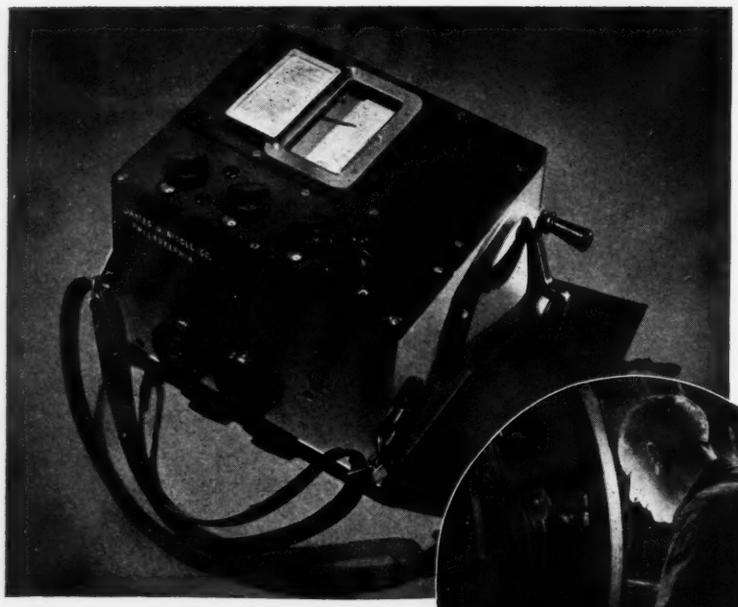


On Superheated Steam Lines, J-M Superex Combination Insulation effectively guards against costly heat waste. Built up of an inner layer of Superex and an outer layer of 85% Magnesia, this combination assures maximum heat resistance and insulating efficiency.

Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE . . .

Superex . . . 85% Magnesia . . . JM-20 Brick . . . Sil-O-Cel C-22 Brick . . . Sil-O-Cel Natural Brick . . . J-M No. 500 Cement . . . Sil-O-Cel C-3 Concrete . . . Marinite



The
"BRIDGE-MEG"
RESISTANCE TESTER

—a combined "MEGGER"* Insulation Tester and Wheatstone Bridge

Range—.01 Ohm to 200 Megohms

For industrial and other engineers who have electrical equipment to install and maintain—here is a *complete* resistance-measuring outfit all built into one portable set that weighs only about 13 lbs. With it you can test the insulation of all types of electrical equipment and detect and forestall trouble. You can measure coils, contacts and relays. You can locate many troublesome faults. The set is portable and rugged—suitable for every day hard use.

Let us tell you more about this unique instrument that has the remarkably wide range of .01 ohm to 200 megohms. Self-contained constant-pressure generator rated 250, 500 or 1000 volts d.c. Write for descriptive Bulletin 1615-P.

* Trade Mark Registered U. S. Pat. Off.

James G. Biddle Co.
1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

Formula for Operating Results

(Continued from page 98)

feedwater and also keeps the amount of exhaust going to the atmosphere below the point where spray begins to give trouble on the building terraces.

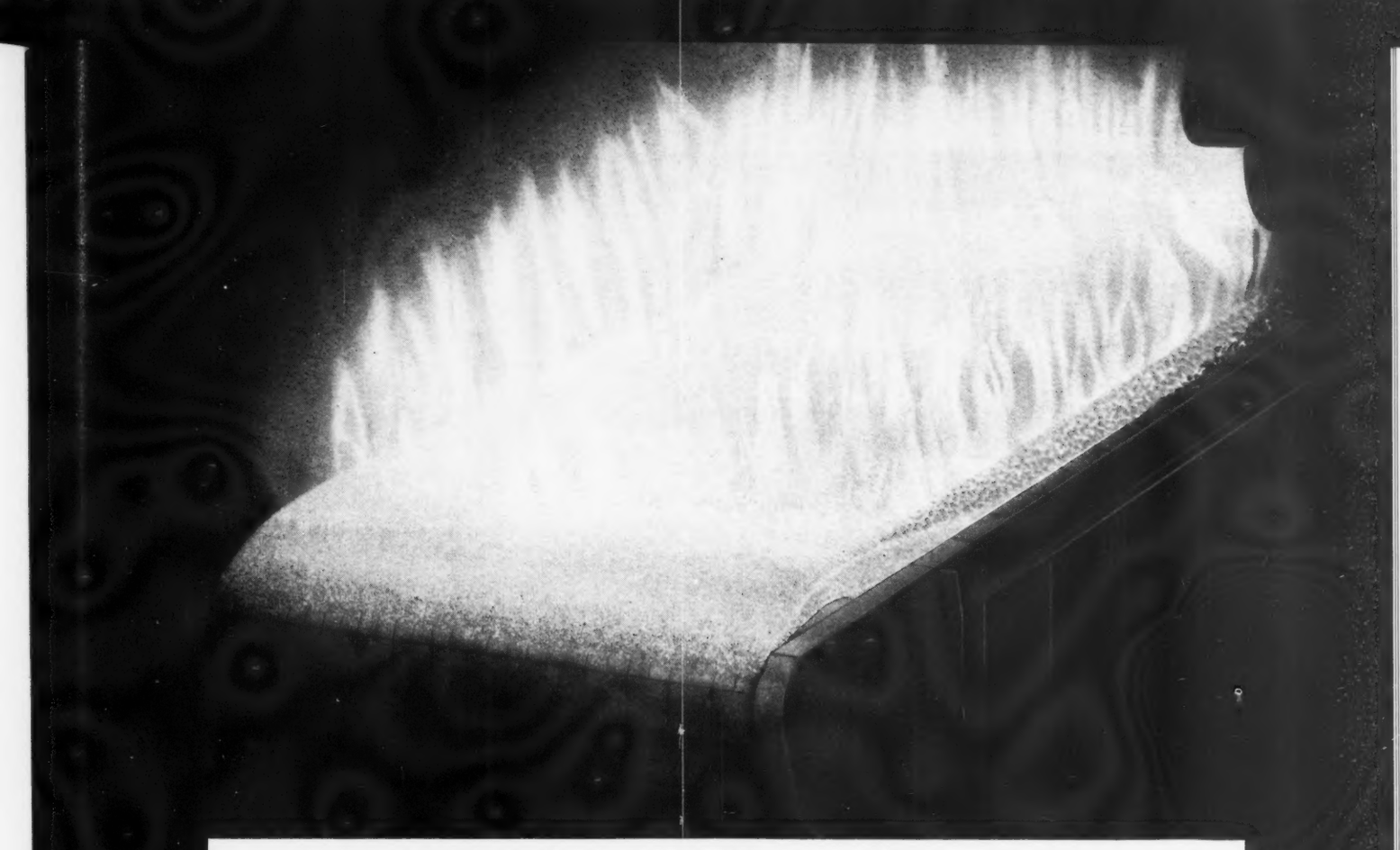
When the steam engine is in operation, cylinder lubricating oil may get into the feedwater. The first preventative is to use only sufficient high-grade oil to lubricate the engine cylinder. All exhaust from the engine is taken through a double-baffle oil separator, which removes a large part of the oil. A marine-type filter box, between the feedwater heater and feed pump, acts as a third line of defense against oil.

This filter box, made of sheet steel and insulated (see Fig. 5) is divided into four compartments by double vertical baffles. About one-third the way down is a horizontal filtering element made of loofer sponges supported between two perforated plates.

Feedwater from the heater comes into the filter near the top of the left-hand compartment, flows down through the filtering element around under the first baffle and over the second into the second compartment. This operation is repeated in the second and third compartments, from where water goes to the fourth compartment, to the feed-pump suction and to the boilers. Most of the small amount of oil in the feedwater is trapped in the first filter compartment.

The two end compartments of the filter are vented to atmosphere through ¾-in. pipes extending up above the water level in the feedwater heater. A tap off the vent on the receiving compartment leads to the condensate inspection tank for the oil heater. When the engine is operating this valve is kept open one-half turn to drain off any oil that may accumulate above the water in the compartment.

Once a month the filter is opened, cleaned out and the sponges renewed. In spite of these precautions, a small amount of oil found its way into the boilers. This has been eliminated by installing a surface blowdown in the rear drum of each boiler. Fig. 6 shows the location and construction of the blowdown. Its intake consists of a 12- to 2-in. pipe reducer, bushed in the 2-in. end for a 1½-in. pipe. One of the drum heads is drilled and tapped for a 1½-in. nipple for making the inside and outside connections to the blow-



Get 33% to 100% increased output from your present boilers--

with a minimum of new capital investment— 50 to 70 day delivery!

● If you want more steam—quickly—investigate Stowe Stokers. Find out how easily they can be installed under your present boilers in place of your older type stokers. By increasing the output of your present boilers, Stowe Stokers will give you more steam—not next year—but within the next few weeks. They have greatly increased the steam outputs of other plants. Let us show you what they can do for you.

Typical examples of the increased steam outputs Stowe Stokers have made possible include: A large automobile manufacturer who jumped his boiler output from 200% to 400% of rating when he put in a Stowe Stoker—and has bought 7 more since . . . and a large utility that jumped the capacity of a unit from 75,000 to 135,000 lbs. of steam with a Stowe Stoker—and has bought 2 more since. Other installations in the mining, quarrying, leather, rubber, textile, tobacco, and salt industries—to name only a few—all are producing the desired results.

Get more complete details today. Send for our completely illustrated catalog—or a Stowe Stoker engineer to talk over and show you how a Stowe Stoker will get you more steam—quick. There's no obligation either way. Write, telephone or telegraph to:—

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STOWE STOKERS

★ ★ GIVE YOU MORE STEAM FROM LESS COAL ★ ★

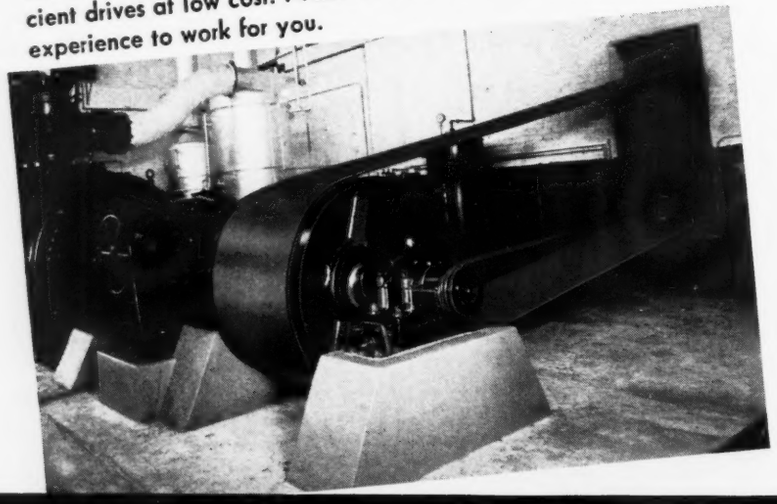
POWER
via Rhoads Tannate
MEANS PRODUCTION
WITHOUT INTERRUPTION

For the 750 HP Diesel engine drive shown below, Rhoads recommended a 32" four-ply special TANNATE Belt. Today, the belt is running perfectly and gives every promise of years of efficient, trouble-free service.

Rhoads has helped thousands of firms throughout industry to determine the right set-up for a specific problem . . . so that, from prime mover to driven machine, power flows smoothly and with maximum efficiency.

Today, it is important to keep production moving smoothly, and to keep unit cost down. You'll find it a great help, a short-cut, and a time-saver, to call on Rhoads for advice.

Thousands of firms have found this a good way to obtain efficient drives at low cost. A note on your letterhead puts Rhoads experience to work for you.



STEP UP PRODUCTION WITH
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WATERSHED
LEATHER BELTING
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NEW YORK · CHICAGO · ATLANTA · CLEVELAND

down piping. Inside the drum the blowdown is securely anchored to the feedwater piping and supported from the bottom of the drum. Discharge from the surface blowdown goes into the blowdown tank.

The top of the blowdown intake is set about 2-in. below the normal water level in the boiler. Before blowing-down, the water level is raised about 1 in. and blowdown is continued until steam begins to blow. Normally the boilers are blown down once a day, using the surface blowdown and the mud drum connections on alternate days. Since installation of the surface blowdowns, there has not been the least sign of oil in the gage glasses, where in previous years it was quite evident. Periodical tests are also made on boiler-water samples, none of which have shown any indications of oil.

A careful check is kept on quality of the boiler water. This work is directly in charge of the Water Service Laboratories chemists who make a weekly water test. In addition, the chief engineer tests alkalinity and chloride daily; this data governs the amount of treatment fed into the boilers.

Operators maintain the plant in first-rate condition. As already mentioned, the turbine-driven generator carries the load in winter and the engine unit in the summer. Each summer, the turbine and its associated equipment is put in A-1 shape for the next season's run. In winter, the engine unit is given similar treatment. During these annual overhauls generators are cleaned and insulation is checked with a Megger by the insurance company.

During summer months, one boiler is enough to carry the load. In this period, each boiler is thoroughly cleaned, inside and out. All brick work inside the furnace and boiler baffles are checked and any defects corrected. When the boilers go back into service they are as clean and the brickwork as tight as when they first went into operation. A careful watch is kept on the boiler brickwork during the operating seasons; air leaks are stopped as soon as they are discovered. To assist in detecting these leaks the brick work is painted white.

Engineers' Books

(*Continued from page 116*)

present the whys, hows and whats of patents in a way that makes the work useful to engineers as well as laymen. The book includes a large number of specific examples which enable the

Here's the "IDENTIFICATION DISC" of CHAPMAN'S NON-SLAM CHECK VALVE

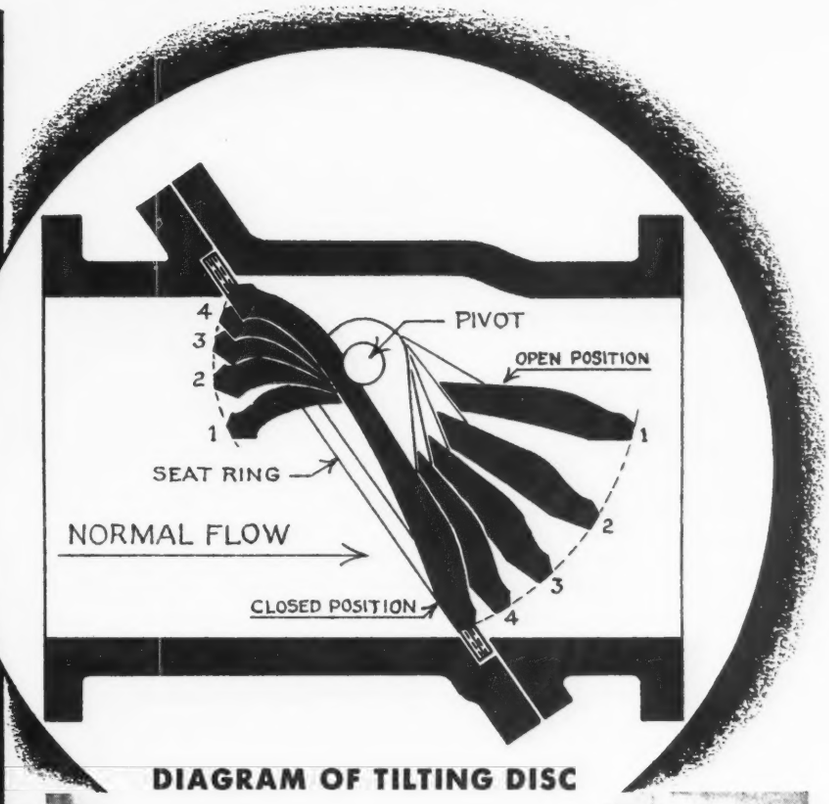
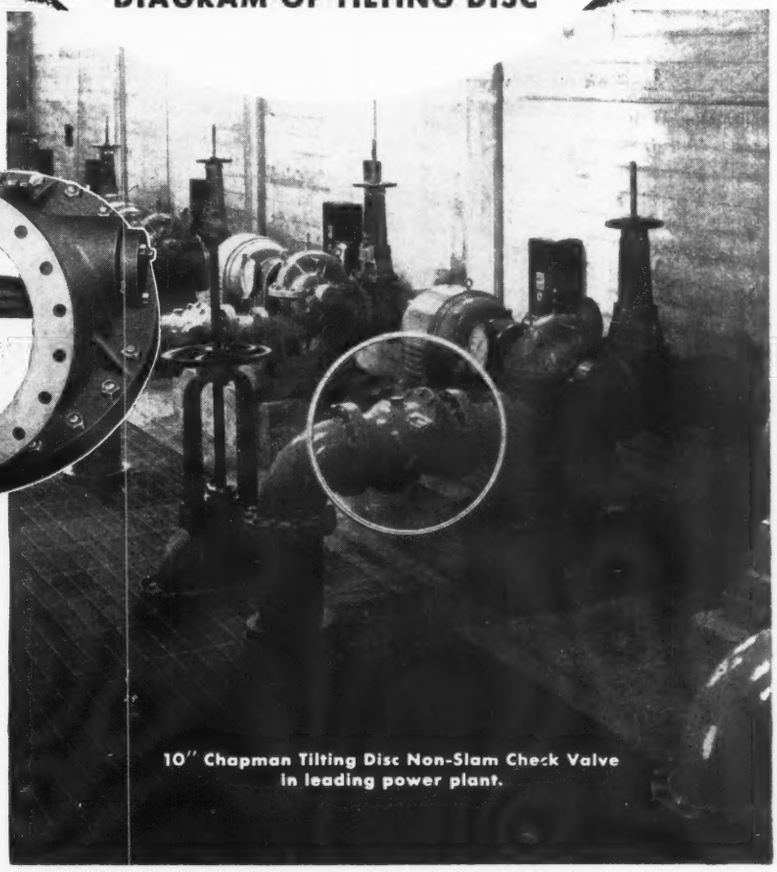


DIAGRAM OF TILTING DISC

Disc clears seat as it pivots—lifts from seat when opening, eases into contact when closing. Rides flow lightly, offers less resistance. No flutter



10" Chapman Tilting Disc Non-Slam Check Valve in leading power plant.

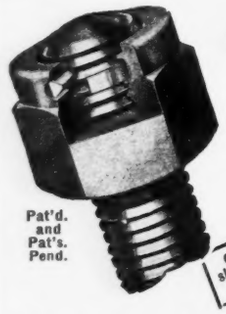
This Exclusive Tilting Disc Cuts Head-Losses 65% to 80%... and Cuts Pumping Costs as much as $95 per valve, per year

TESTS AT CORNELL AND M.I.T.... and in actual service in many modern power plants . . . prove that Chapman's Tilting Disc (graphically shown above) closes drop-tight without rubbing or wear on seat. *Result:* No slam, vibration or surging . . . no opened pipe-joints. And the check valve itself wears so slowly that maintenance is almost nothing at all.

NEW FREE BOOK gives the whole story of Chapman Tilting Disc Non-Slam Check Valves in 12 quick pages . . . actual test-results, power plant photos, engineering data on installation and regulation, list of alloys available. *Send today for YOUR copy of this new book.*

The CHAPMAN VALVE MANUFACTURING COMPANY

INDIAN ORCHARD, MASSACHUSETTS



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Years of actual service prove that "PYREX" Gauge Glasses last longer because:

1. Their machine drawn accuracy minimizes breakage due to installation strains.
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3. They are fully capable of withstanding the maximum working pressures for which they are recommended.
4. "PYREX" Gauge Glasses resist the corrosive action of steam and remain clear and unclouded over long periods.

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reader to study the applications of basic principles which underlie patent law.

A survey is given of Patent Office organization and procedure so that the reader may obtain a knowledge of the technicalities involved in patent investigations and in obtaining a patent. The work is divided into nine chapters: Types of inventions; nature of a patent; how patents are classified; preparation and prosecution of applications; inventions as defined by patent claims; what is invention; utility, mortality, frivolity; plant patents; and dealings in patents. Everyone interested in patents and patent law should find this book both interesting and helpful.

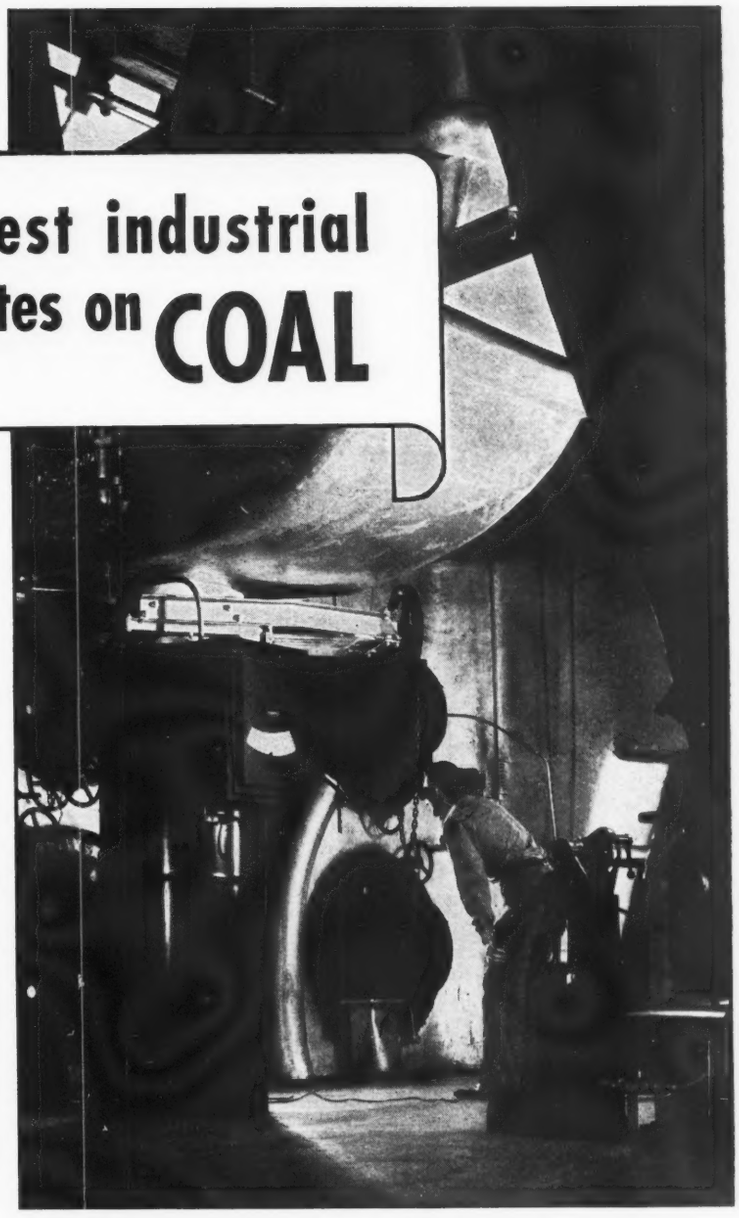
Brief Reviews

HANDBOOK OF WELDED STEEL TUBING —(Revised). *Published by Formed Steel Tube Institute, 1621 Euclid Ave, Cleveland, Ohio. 86 pages, looseleaf bound. Charts and tables. Price $1.00.*—Furnishes designing engineers with full information regarding standard sizes and properties of welded tubing. Book is devoted exclusively to those grades of welded tubing which can be figured as having a solid wall structure with no discontinuity or variation in physical properties occurring in the area affected by the welding operation during manufacture. Manufacturing and fabricating processes illustrated and dimensioned drawings show typical examples to what degree welded tubing can be cold-worked in such operations as bending, beading, flanging, expanding, tapering.

NEW YORK STATE BOILER CODE (Revised—now in two volumes). *Published by State of New York, Department of Labor, Albany, N.Y. For copies, refer to Bureau of Printing, Room 905, State Office Bldg, Albany, N.Y. Price $1.00 per volume.*—Part I contains only general rules and information necessary for the installation and operation of power boilers, miniature boilers, locomotive boilers, and also rules applying to inspection. Part II, or Volume II, contains all information applying to materials to be used in connection with boiler construction.

ELECTRICITY UTILITY STATISTICS. *Published by Federal Power Commission for year ended Dec. 31, 1939. Cloth bound, 500 pages, priced at $2.00. Order only from Federal Power Commission, inclosing cash, check or money order. Stamps not acceptable.*—Presents in uniform manner detailed operating and financial statistics of all privately owned electric utilities in the United States receiving annual electric

The South's newest industrial power plant operates on COAL



...THE DEPENDABLE MODERN FUEL!

THE AMERICAN VISCOSE CORPORATION'S power plant, at Front Royal, Virginia, is the largest in the world devoted solely to supplying power for making rayon yarn. As modern as its product, this plant has five turbine generators capable of putting out a steady supply of 24,000 kilowatts—enough electricity to satisfy the domestic needs of a city the size of Pittsburgh. The three boilers burn nothing but modern, prepared COAL. They are fed this trouble-free, economical fuel by a battery of pulverizing mills capable of delivering 72,000 pounds of coal per hour. With their modern equipment and fuel, these boilers operate at a guaranteed efficiency of 86 per cent.

May we help you boost YOUR power plant efficiency?...Many power plants today are reaping the benefits of consultation with Chesapeake and Ohio Fuel Service Engineers. These trained specialists will be sent ...absolutely without charge...to survey your plant, confer with your engineers and make suggestions leading to fuel and maintenance economies and to higher boiler efficiencies. If you would care to receive this service, write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, Ohio. It will cost you nothing—and it may save you a substantial sum of money!

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Chesapeake and Ohio Lines

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JOLTS!
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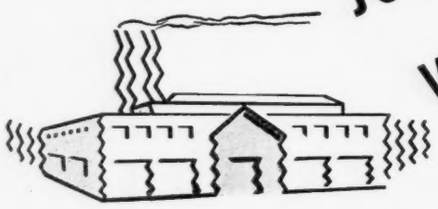

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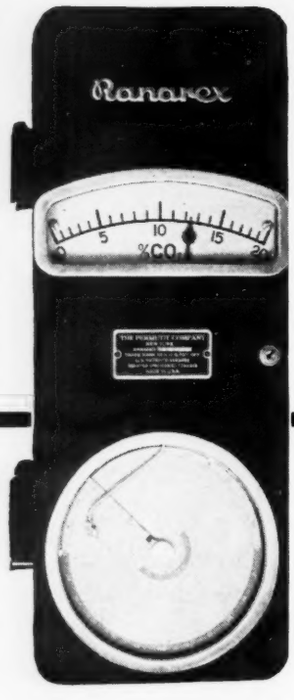

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revenues of $250,000 or more. Statistics shown in the volume are most detailed and authoritative data available, and have been compiled from reports filed with the Commission by Class A and B electric utilities, whether or not otherwise subject to its jurisdiction.

NEW TRENDS IN BOILER FEEDWATER TREATMENT. *By Frederick G Straub, Research Assoc Professor of Chemical Engineering, University of Illinois. Published by Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $.15.*—Paper reviews the new trends in boiler-water treatment for the prevention of scale, corrosion, embrittlement and carryover. These include the latter developments in cold process softeners and the organolites or Zeo-Karb softeners. Consideration is given to the latest methods used for prevention of silica scale, as well as the so-called "Threshold Treatments" for stopping scale in condensers and heat exchangers. Newer types of steam purifiers are described, and there is a discussion on corrosion in the "steam-blanketed" areas of the boilers.

STRUCTURAL DESIGN OF REFRACTORY CONCRETE. *By R T Giles, the Atlas Lumnite Cement Co, New York, N. Y. 18 pages, paper bound, tables. No price listed.*—With charts and sketches this booklet describes methods of building industrial furnaces and kilns with reinforced refractory concrete. Principles used in designing concrete for service at high temperature, differing from those on which ordinary concrete design is based, are presented as applied to specific types of furnace construction.

ASTM STANDARDS ON REFRACTORY MATERIALS. *Published by American Society for Testing Materials, 260 S Broad St, Philadelphia, Pa. 180 pages, diagrams, curves. Price $1.50, board bound; cloth bound, $1.75.*—1940-41 edition of standards presents latest approved ASTM specifications, tests, and definitions covering these materials, and gives considerable other information and data significant in the refractory field.

BURNING FUEL OIL. *Published by Combustion Service Co, 1451 Broadway, New York, N. Y. 26 pages, paper bound, available on request to oil-fired-plant operators.*—Gives grades of fuel oils available, composition of oils, oil burner systems, principles of efficient oil firing, fuel oil testing, fouling tendencies of fuel oil, and describes liquid "Kleen-flo", its principle of operation, advantages, and operating records of plants using same.

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Extra strength in malleable fittings means that every joint in your piping systems will stand up longer, more dependably, without maintenance.

That is what you get, *at no extra cost*, when you specify Grinnell Malleable Pipe Fittings! Every one is made from superior malleable iron produced by exacting Air-Furnace process . . . 20% tougher, stronger than ordinary cupola-made malleable . . . more uniform in every detail of metal structure and finish.

Get this extra value throughout your piping systems with Grinnell Air-Furnace Malleable Fittings. Made in all standard types and sizes. Available everywhere through wholesalers, heating and plumbing contractors, and branch offices in all principal cities. Write for comprehensive catalog, "Grinnell Pipe Fittings". Grinnell Co., Inc., Executive Offices, Providence, Rhode Island.

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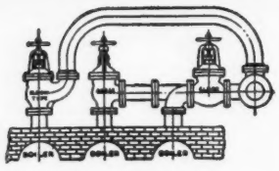
SPECIALTY

VALVES



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• You can make safety in your boiler plant a certainty when you use G-A triple-acting non - return valves. There'll be no boiler explosions or bursting steam lines to damage life and property when you use this double cushioned valve that will not stick or chatter. Comes with either flanged ends or welded necks, and handles 150 lbs., to 1500 lbs. Test it under pressure . . . it's the heaviest valve of this kind made. In angle, globe or elbow types from 2½" to 16" in size. Free G-A catalog describing complete line will be sent to you upon request.

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Altitude Control . . . Pressure Reducing . . . Throttle and Emergency Stop . . . Check Valves etc.

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EIGHTH ANNUAL REPORT. *Engineers' Council for Professional Development, 29 West 39th St, New York, N.Y. No price listed.*—Quality of engineering, as a profession, is growing, according to this report. This is being done largely through activities of accredited curricula, and in improving the admission of suitable students to the profession. Also listed are the 125 institutions in the United States and Alaska that have been accredited by the society.

Reader's Problems

(Continued from page 107)

catch a few minutes sleep, also standing around were several others with nothing to do. For an instant he looked us over and made a fateful decision. He told me to get a pair of tongs and a "dolly bar" and get up on the main bearing, two other men were given 14-lb sledges and stationed on each side of me. Our job was to drive the pin out in case anything went wrong.

Well, gentle readers, more happened in the next few minutes than should happen in a life time. The Chief took a last look around to see that every man was in his place and gave the word to start. The first thing that happened was that one of the oilers grabbed the blow torch where it was hot. He let loose with a yell and the torch fell, rolled over, and upset the bucket. Clyde jumped in time but the pin rolled down in an open drain where he hurriedly retrieved it. Wiping off the debris, he started for the disk.

As he was about to step up on the foundation, his foot slipped and down he went with the pin. Again he made the attempt, this time getting it in the hole and Mac, being on the alert, gave it a bump with his 4 x 4 and then, Harry and Ed being ready, each took a healthy swing and the pin was coming "home." From my point of observation, I could see that everything was going good. The Chief also could see it was going in and in his excitement he yelled "hit it, damn it, hit it", and as he said those words he looked up at us on the bearing.

I had the dolly bar in place and the next thing I knew WHANG, the man on my right let loose, the pin started out, then Harry drove it in. The man on my left, not to be outdone, drove it out. Ed came in with his lick but the poor pin by this time had enough; it stopped (froze), and no amount of sledging could move it either way. We looked at one another, saying nothing. The Chief was doing enough swearing for all of us.

There was nothing for us to do but wait until the disk cooled enough so we could go to work again with the "old man" and drill it out. We got started on Tuesday noon with hardly any one in the plant on speaking terms. No, I will not try to tell AW what loosened his pin, but I know what loosened ours—it was what we used for steam, 50% steam, 40% water and 10% soda ash.

Los Angeles, Calif. A C ELDER

Here's a record of Efficiency and Low Cost with

PHOSCALOID

After Treatment in a Prominent Steel Mill . . . .

A recent interesting case with Phoscaloid is where a 20 lb. rate per 1,000,000 gallons in one plant maintained the same 30 to 50 p.p.m. excess PO_4 in the boiler concentrates as a second plant using an 18 lb. rate of Soda Phosphate, containing a much higher percent P_2O_5 per pound, both plants using a 100% make-up from the same lime-soda softener. The cost of the after PO_4 treatment was absolutely cut in half by the Phoscaloid substitution.

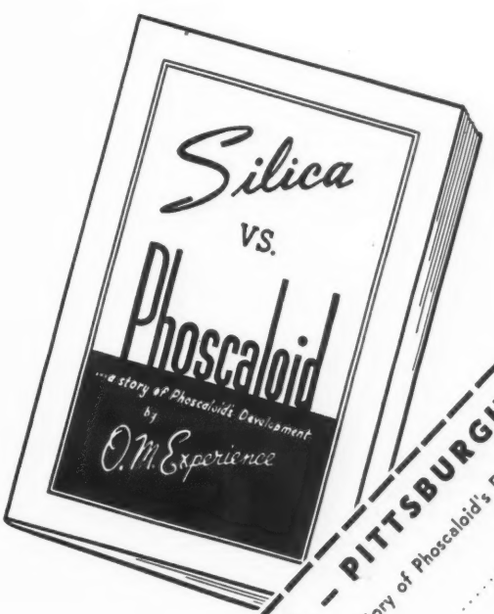
Yes, crazy-looking results, especially in view of the fact that the same PO_4 boiler concentrations were maintained by the Phoscaloid with 30% less P_2O_5.

The answer here is that the Calcium prefers to react first with the Protein in the Phoscaloid in the formation of Calcium Proteinate before reacting with the Phosphate in the formation of Calcium Phosphate. Such practices are sound, and sensible because the organic-inorganic compounds thus formed are definitely non-structural forming and as such "ball up" the cementing influences of the large relative amounts of silica that are harbored in all lime-soda and Zeolite processed waters.

These are interesting and true results with Phoscaloid at a large steel mill in the Pittsburgh territory.

While the use and processing of Proteins with Phosphoric Acid in the production of Phoscaloid are fully covered by U. S. Patents, you will find them no more expensive per unit reaction value than commercial Soda Phosphates.

This treatise on after treatment contains an interesting history of Phoscaloid . . . what it is . . . what it does . . . how it's used. It also tells of the 6 years of successful application and how it has become the most popular low cost after treatment. Use the coupon or a request on your company letterhead will bring a copy of this informative booklet.



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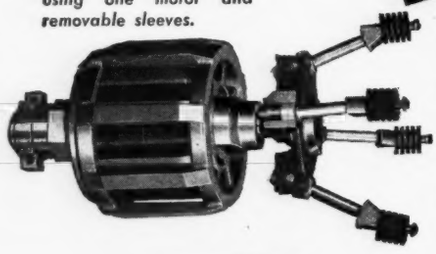
BIG TUBES LITTLE TUBES
CURVED TUBES BENT TUBES
ALL TUBES

Clean them WITH ..

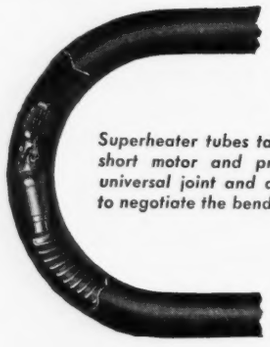
LAGONDA-LIBERTY TUBE CLEANERS

Cleaning of several sizes of large tubes or pipes can be accomplished by using one motor and removable sleeves.



If a tube can be cleaned mechanically, Elliott has the cleaner to do it! This means a lot of tube cleaners. It also means a lot of experience. Both of these factors are essential to the correct cleaner selection for *your* particular tube cleaning job.

The cleaners pictured at the left are *extreme cases,* which will give some idea of the many sizes and types that are ready to do a speedy, time-saving job for you. Elliott engineers, at Tube Cleaning Headquarters, are eager to help you in your selection of the right cleaners for your particular work.



Superheater tubes take a short motor and proper universal joint and cutter to negotiate the bends.

For extremely short radius bends a compact cleaner with hinge coupling and telescoping cutter is available.

You'll want the "inside story" on tube cleaning. It's all in the Lagonda-Liberty Bulletin. Write for your copy today.

ELLIOTT COMPANY
LAGONDA-LIBERTY
Tube Cleaner Dept., SPRINGFIELD, OHIO
District Offices in Principal Cities Y-162

Power Lines

(Continued from page 130)

was elected president of the Engineering Societies of New England, Inc, on April 30, to succeed Holcombe J Brown, whose term expires this summer. He is past chairman of the Boston Section, American Welding Society; served two years as treasurer of the ESNE, and has been vice-president for several years.

GEORGE C EATON, who has been power sales manager of the Boston Edison Co for the past two years, has been appointed assistant superintendent of production for that utility. He fills the post of H W H Wellington, who recently succeeded Fred D Knight as head of that branch of the service. Mr Eaton was a member of the production department prior to being transferred to his recent power sales position.

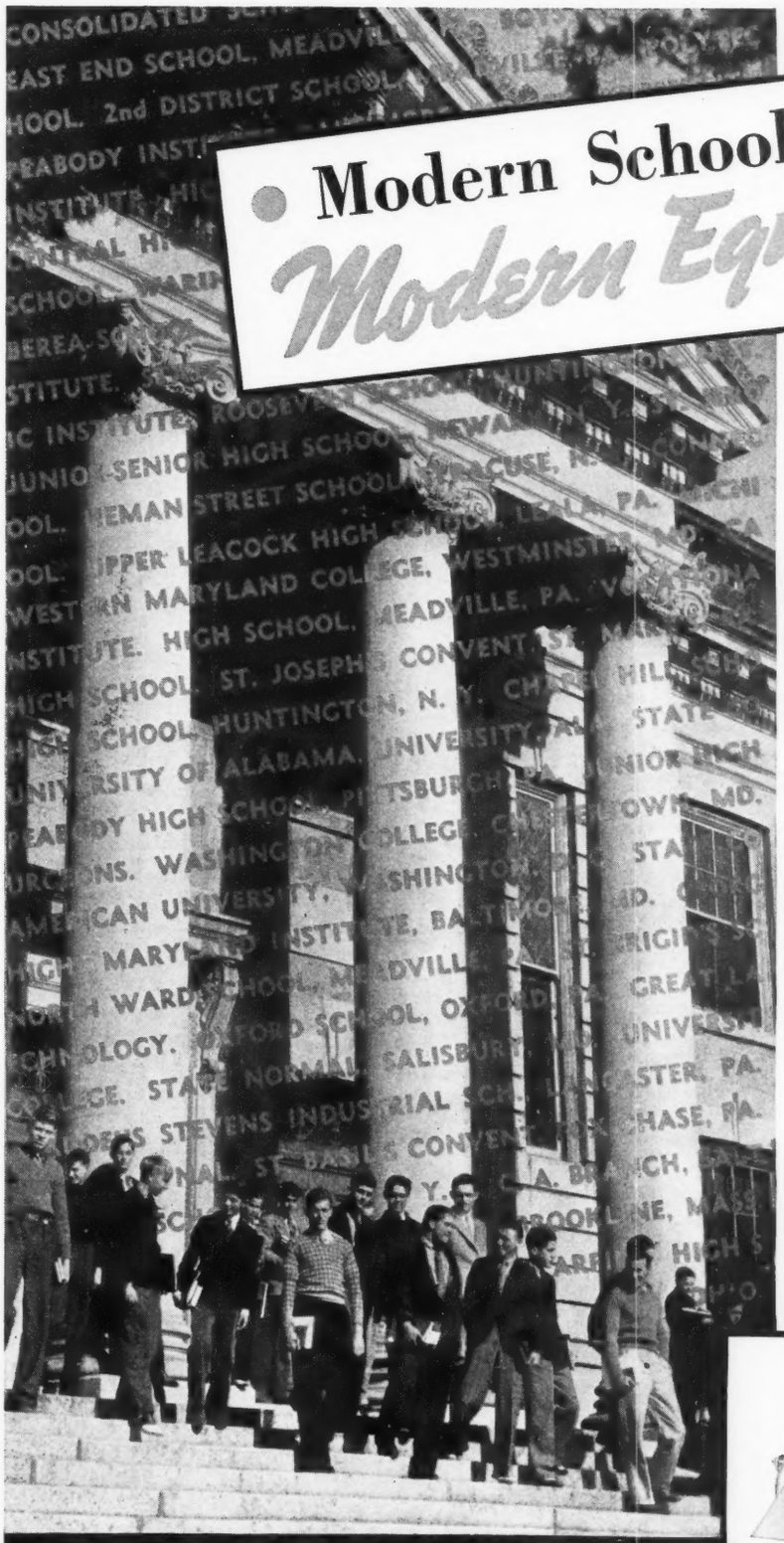
JOHN T WARD, former associate professor of chemical engineering at Massachusetts Institute of Technology, and later director of the research laboratory of the M W Kellogg Co, New York, has been appointed power sales manager of the Boston Edison Co, succeeding G C Eaton. Mr Ward is widely known in oil engineering and power-plant piping fields, and is also director of the Boston Edison radio department.

CLAUDE L DRAPER has been reappointed by President Roosevelt to another 5-year term on the Federal Power Commission. This was the only one of the five Commissioner's terms to expire this year.

GEORGE PARKMAN has been appointed director of building construction and maintenance of Westinghouse Electric & Mfg Co. Mr Parkman, who has been acting head of the construction department for several months, is now in charge of 11 new building projects for the company, including the new fluorescent lamp plant at Fairmont, W. Va.

OBITUARIES

TREFFLY C CAPISTRON, 47, widely known in northeastern power circles as "Cap", and superintendent of the southern district of the New England Power Assn system, died on April 6, following a heart attack at his office. Mr. Capistron was identified with greater portion of the New England Power system's development, and was familiar with the



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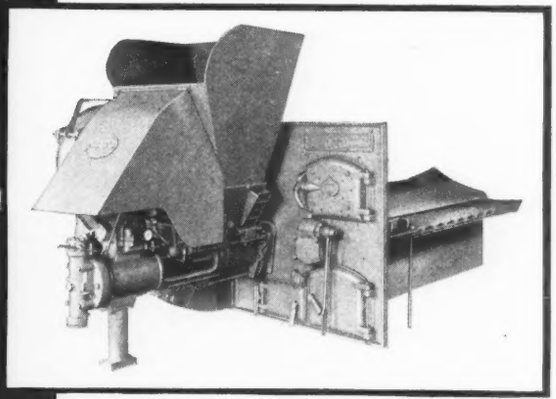
F&E

Stokers

A school, whether endowed or supported by taxpayers, must be a model of efficiency throughout the entire school plant. That's why so many of America's great schools have boilers equipped with "F & E" Stokers—the stokers that assure efficiency where operations really begin—in the boiler room. Under the broad heading of efficiency come economy, dependability, low maintenance and upkeep—the combination of proved advantages that have made "F & E" Stokers the choice of those who demand and expect equipment to give the most in performance at lowest possible cost.

There is an "F & E" Stoker designed for practically every heating or power need for schools and colleges. Every "F & E" Stoker incorporates the patented Interval Timer Governor for perfect coal-feed control and the Straight Line Drive for simplicity and for positive power transmission. Many other features, including the Fuel Bed Regulator and the Sliding Bottom Retort combine to make "F & E" the stoker that offers the utmost in stoker engineering. To these features is added the experience of more than 25 years of manufacturing and installing stokers in every field where heat or power is required.

Consult the "F & E" representative in your territory for complete information.



The Series 60 "F & E" Underfeed Stoker. Designed for boilers requiring output ranging from 5,000 to 15,000 lbs. of steam per hour. Electro-hydraulic or steam drive optional. Air supply and coal feed completely synchronized to give perfect combustion.

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HYDRAULIC & STEAM DRIVE

are manufactured and installed by

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ESTABLISHED 1842 BALTIMORE, MD.

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For
STEAM

The defense program demands uninterrupted service of power plant equipment. Engines and pumps *must* be kept operating at maximum capacity, sometimes twenty-four hours a day—no time for frequent packing replacements.

Here are offered two standard Belmont Packings that *will* withstand the strain—Belmont 30 for reciprocating steam rods and Belmont 754-P for rotating steam shafts. TRY THEM NOW!

Write on your company letterhead for Belmont Catalog No. 40 which describes Belmont Packings for all services—a text book guide on applications. An authorized Belmont distributor will be glad to show you samples and help you with *your* particular requirements.

BELMONT PACKINGS

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

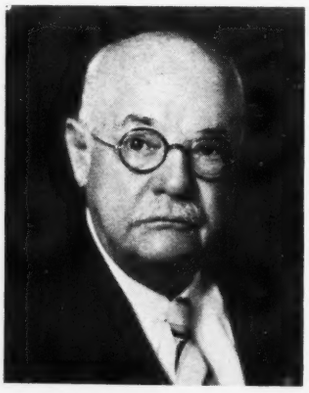
FOR RECIPROCATING STEAM RODS
BELMONT 30
For reciprocating steam rods where boiler pressure is in excess of 100 pounds, (340 degrees F.)
FOR ROTATING SHAFTS
BELMONT 754-P
Practical and reliable for rotating shafts, all temperatures.

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

★ ★

operation of its hydro-electric plants, transmission lines and interconnected steam plants of the territory. Before going to Rhode Island in 1935, he was superintendent of the Central Div, New England Power System, with headquarters at Worcester, Mass.

FREDERICK C BRYAN, for 30 years general traffic manager of Allis-Chalmers Mfg Co, died at his home in Milwaukee, April 7. He was born in Raleigh, N. C., in 1864, and attended Bingham Military School, the University of North Caroiina, and the Eastman School of Business in Poughkeepsie, N. Y. His career on railroading and traffic management started at the age of



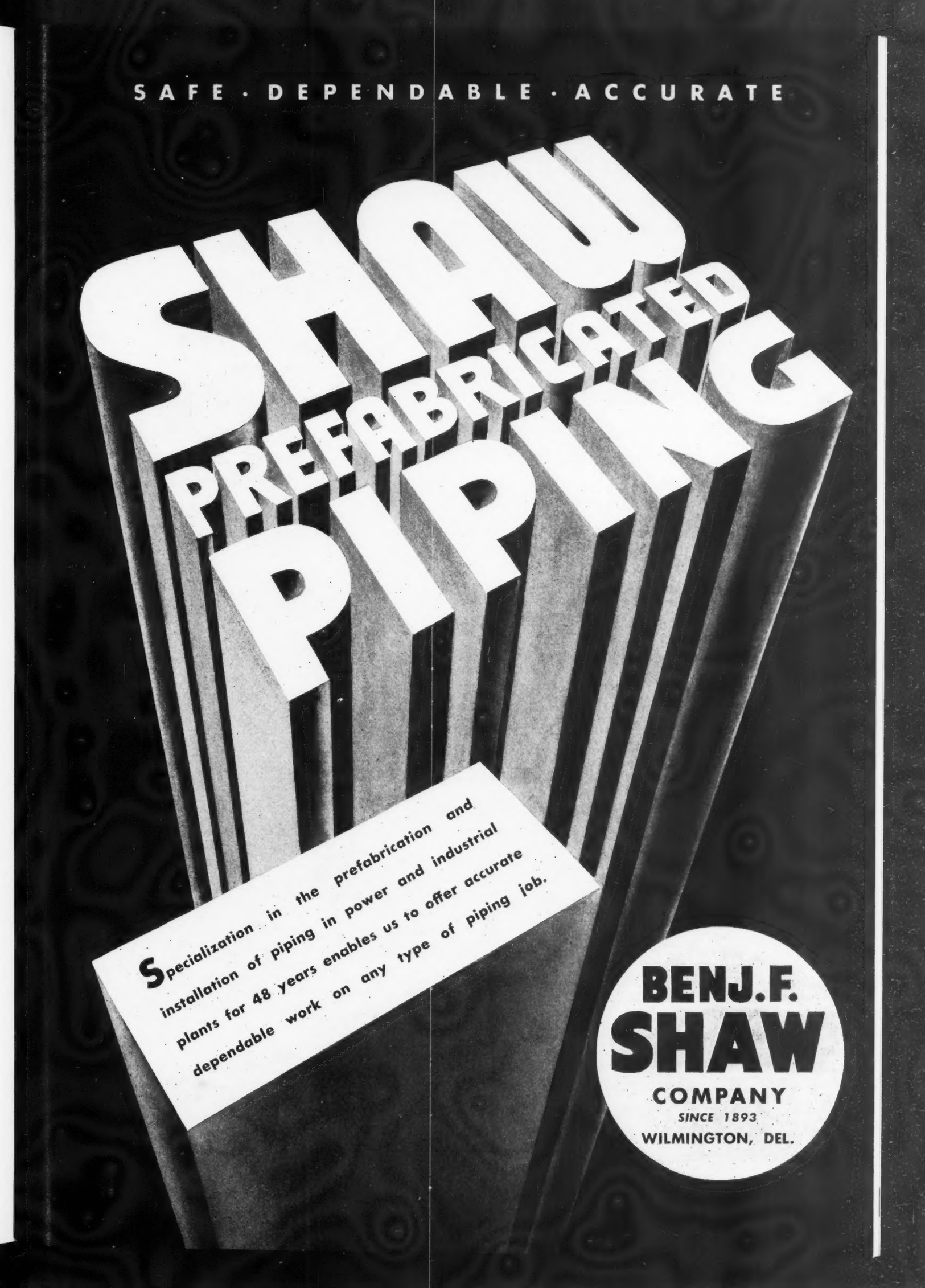
F C Bryan

19. when he joined the Atlanta and North Carolina R R as a clerk. In 1905 Mr Bryan stepped out of railroading to become vice-president of the St. Paul and Western Coal Co and of the Boston Coal Dock and Wharf Co, St. Paul, Minn., at that time second in world trade of bituminous coal. It was from this position that he came as traffic manager to Allis-Chalmers.

HOWARD ASHLEY PEDRICK, inventor of the process of imparting tension to piston rings by heat, died March 5, at the age of 79, at State College, Pa. Mr Pedrick's invention was patented and is one of the almost 50 patents obtained by him during his lifetime.

WILLIAM E J GRAHAM, 55, chief engineer at the Concord, Mass., Reformatory for the past 19 years, died of a heart attack on April 10. Mr Graham was formerly engaged in power plant operation at Woburn, Mass., and was well known in Bay State institutional engineering circles.

ERNEST B NEAL, 73, vice-president of the Kinney Mfg Co, Jamaica Plain, Mass., passed away at the Quincy, Mass., Hospital, on April 18. He was born in Gardner, Me., was a former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PIPING
Specialization in the prefabrication and installation of piping in power and industrial plants for 48 years enables us to offer accurate dependable work on any type of piping job.
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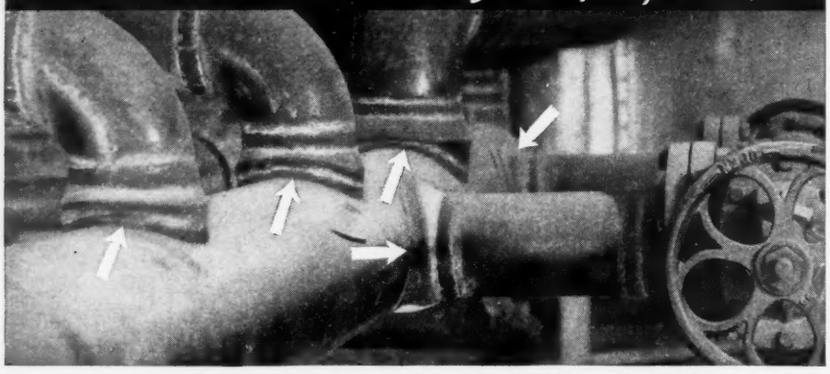
WELDOLETS·

TRADE MARKS - REG. U. S. PAT. OFF.

THREDOLETS

. . . Welded Outlets for Piping . . .



Header Construction Made Easy with WeldOlets and ThredOlets

WELDED header construction is simplified by using Bonney WeldOlets and ThredOlets in making branch "take-offs".

WeldOlet

Not only do they eliminate all cutting and fitting of the main pipe, but they provide leak-proof joints of full pipe strength. They may be installed on the main either before or after erection and without the use of templets.

ThredOlet

They are designed with a heavy, external rib to compensate for the loss of strength in the main pipe that occurs when the hole is cut.

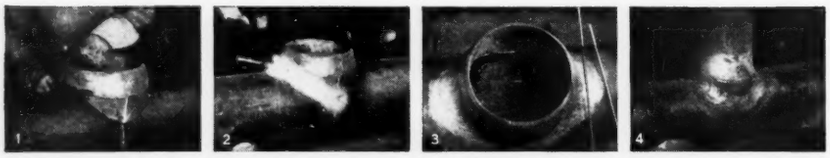
Their funnel-shaped aperture keeps turbulence and friction to a minimum and their wide footings offer ample resistance to bending stresses.

Socket-End WeldOlet

WeldOlets and ThredOlets are recommended for all commonly used pressures and temperatures on all types of piping installations.

Be sure you have full information about all the advantages of WeldOlets and ThredOlets before doing your next piping job.

AS EASY AS LIGHTING YOUR PIPE



(1)—Select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position. (2)—The fitting is then welded into place by the electric-arc or oxy-acetylene method. A junction of full pipe strength and a leak-proof outlet is the result. (3)—Where the outlet is 2" or larger, the button should be removed after the welding operation. On small sizes the fitting is used as a templet and the hole is cut in the main pipe first, either with a hole saw, the torch or by drilling. Inspection of the inside of the joint is possible by using WeldOlets and ThredOlets, allowing removal of all scale, welding metal, etc. (4)—The branch line is then welded into position. In the event a ThredOlet is used the branch pipe is threaded and screwed into place.

BONNEY FORGE & TOOL WORKS

Forged Fittings Division - Allentown, Pa.

Forged by the Makers of

The Finest that Money Can Buy

BONNEY TOOLS

president of the Hydraulic Institute of the United States, and former president of the Kinney Co.

CARL A BENGTSON, 81, first chief power engineer employed by Norton Co, Worcester, Mass., died recently at his home in that city. He was a native of Sweden and retired 9 years ago after 45 years of service.

ALFRED S KELLOGG, 74, for many years prominent in heating, ventilating and power-plant engineering circles at Boston, died at the Cambridge Hospital on April 16, following a heart attack. He was president of the Engineering Societies of New England, and was past chairman of the Massachusetts Chapter, American Society of Heating and Ventilating Engineers, and of the Boston Section, American Society of Mechanical Engineers.

FRANS H C COPPUS, chairman of the board of directors, and founder of Coppus Engrg Co, died recently. He was active in engineering circles and was well known in the engineering world.

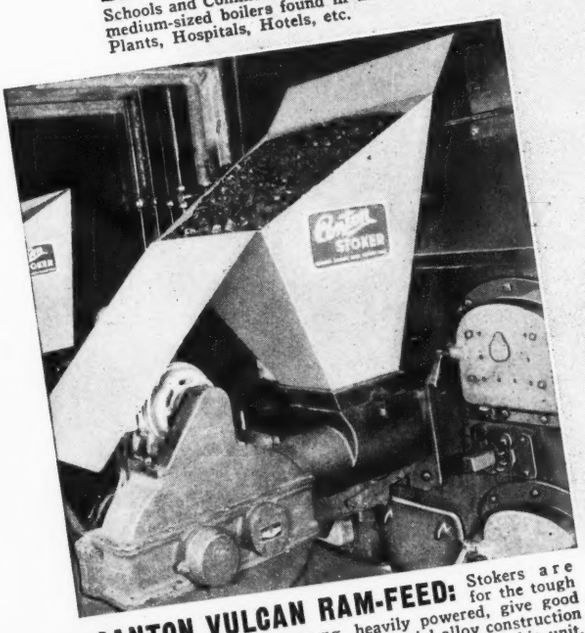
EDWARD W BURBANK, 52, former manager of Dallas, Texas, office of Allis-Chalmers Mfg Co, from 1922 to 1940, died April 20, after a prolonged illness. He started with the company as student apprentice in 1911 after being graduated from Tulane University, and served in a variety of engineering and sales work. He was a member of the American Society of Mechanical Engineers, and had been on its board of managers.

FRANKLIN P JACKSON, 46, assistant to the president of the New England Power Assn, died April 25 of heart attack, near Havre de Grace, Md., en route to his home in Wellesley, Mass. Following his discharge from service after the World War, he joined the New England Power Co, and in 1927 was made assistant treasurer of the Narragansett Electric Co. In 1928 he came to Boston as assistant treasurer of the N E Power Assn, and was made assistant to the president in 1937.

DR MORTON G LLOYD, chief of the Safety Code Section, U. S. Bureau of Standards, since 1917, died at his home in Chevy Chase, Md., April 26, after a brief illness. He was a fellow of the American Institute of Electrical Engineers, member of the Washington Academy of Sciences, American Association of Engineers, president of the International Association of Electrical Inspectors, and was identified with a score of

NAME *Your* JOB...

LO-SET RAM-FEED: This CANTON unit is helping to cut heating costs in medium-sized boilers found in Laundries, Dairies, Packing Plants, Hospitals, Hotels, etc.



CANTON VULCAN RAM-FEED: Stokers are for the tough loads. They are built strong, heavily powered, give good results even with low grade fuels. Special alloy construction and a 5-year guarantee indicate the plus value of this unit.

THERE'S A TYPE OF CANTON STOKER TO FIT EVERY FUEL-BURNING REQUIREMENT

CANTON'S experience with fuel-burning equipment covers a thirty year period during which we have designed and installed virtually all types of stokers including Hand Stokers, Overfeed Stokers, Worm Underfeed and Ram Underfeed units.

In surveying any steam plant, therefore, it is not necessary for us to be partial to any product design. The full coverage of the CANTON line enables us to render a stoker engineering service that helps assure each client the particular stoker design best suited to his plant layout.

That is why we continue to suggest to plant owners and engineers everywhere—"Name Your Job, There's A Type of CANTON STOKER to Fit Your Fuel-Burning Requirements." Write today for latest descriptive bulletins. They point the way to lower steam costs.

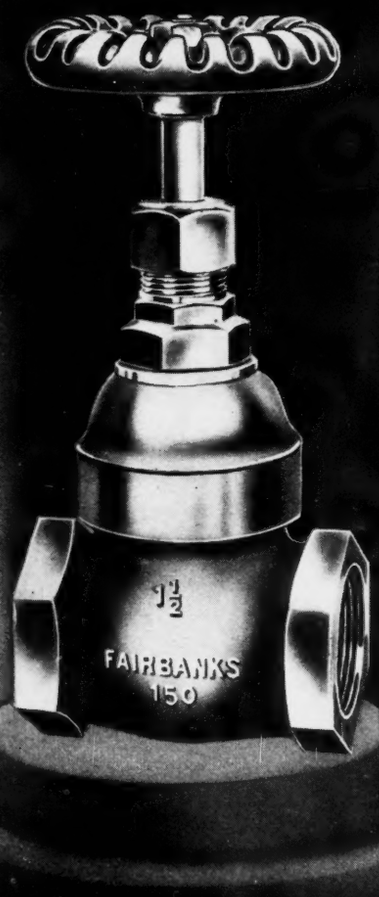
CANTON STOKER

CANTON STOKER CORP. - CANTON, O.

CANTON STOKER CORPORATION

900 ANDREW PLACE, S.W., CANTON, OHIO

FAIRBANKS VALVES



True to a Quality Tradition

Fairbanks Valves are built to undeviating standards of *quality*. They were conceived as *quality* valves, and our strict adherence to this ideal has continued as an unbroken tradition for more than half a century.

Fairbanks workmen are *quality* minded. Theirs is a calling where pride of craftsmanship still prevails . . . where skill of the master hand supplements the accuracy of the specialized machine to maintain Fairbanks' high standard of precision, to safeguard Fairbanks quality.

Write for catalog No. 21 and name of the nearest Fairbanks distributor.

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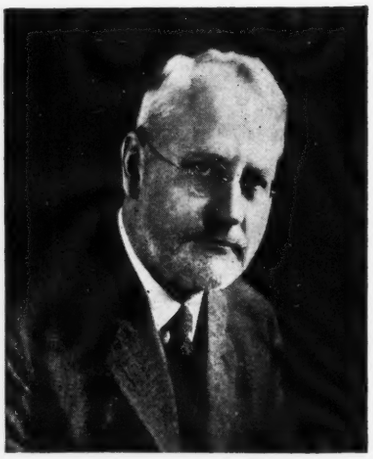
other groups. He was also for some time technical editor of *The Electrical Review* and *Western Electrician* in Chicago.

WILLIAM T RANDALL, Philadelphia sales engineer of the Pangborn Corp, Hagerstown, Md., died suddenly April 14, while on a visit to his summer cottage. He joined the company as Philadelphia representative in 1919 and has been widely known in that district for his services to the foundry and process industries during the past 22 years.

GEORGE H DANNER, president and general manager of Pittsburgh Piping & Equipment Co, Pittsburgh, Pa., died at the age of 66 on April 11. Mr. Danner



George Danner

was one of the original founders of the company nearly 40 years ago, and served as president since its organization.

WILLIAM S RICHHART, 59, superintendent of power production at Spy Run generating plant of Indiana Service Corp, died April 9 while attending the Midwest Power Conference in Chicago. He entered the employ of the corporation as electrical engineer in 1917, and has since served as assistant operating engineer, power operating engineer, electrical distribution engineer and power production engineer. From 1935 to 1938 Mr Richhart was on leave of absence to engage in special engineering work in Indianapolis and New York. He has been associated with the Allis-Chalmers Mfg Co, University of Pennsylvania, and the Westinghouse Electric & Mfg Co. He was a member of the Public Service Commission of Indiana for two years.

RAYMOND N EHRHART, prominent engineer and former executive of the Westinghouse and Elliott Companies,

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New realms of science had to be explored to develop boiler tubes for the safe and economical use of steam at 800° and higher. B&W Seamless Steel Boiler Tubes, based on original research and specialized production facilities, provide the utmost in boiler tube reliability.

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The Heat-Prover is an ingenious device — a by-product of our research in metallurgy. It registers continuously and instantaneously changes in the amount of oxygen and combustibles in furnace gases. It is an excellent guide in adjusting 4-cycle Diesels and for combustion control in heat generating plants. In the heat treatment of metals, it is invaluable. It assures uniformity and reduces scrap losses.

Let us tell you how you can secure the use of one of these machines. Mail the coupon today for further information.

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died April 30, following an automobile accident. Following his graduation from Cornell University he entered the employ of the Westinghouse Co and for many years was closely associated with George Westinghouse. Later he assumed the presidency of the Elliott Co, and after relinquishing that position, engaged in consulting engineering work in New York. He was a member of the Engineer's Club of New York, the American Society of Mechanical Engineers, and the University and Athletic Clubs of Pittsburgh.

CHARLES B JAHNKE, president and general manager of the Cooper-Bessemer Co, died May 6 from a heart attack suffered the week before. Mr Jahnke, born in Cincinnati, was with the Fairbanks Morse Co of Milwaukee for 21 years. He joined Cooper-Bessemer in 1935 as chief engineer, and was named president last December.

BUSINESS ITEMS

W H & L D BETZ announce change of address, effective April 21, 1941. New location is Gillingham and Worth Sts, Frankford, Philadelphia, Pa. Laboratory space of firm has been increased five times former size, office facilities have been increased four times, and manufacturing and formulating facilities 3½ times.

MICRO-WESTCO, INC, Bettendorf, Iowa, announces appointment of H L McNally to position of sales manager of Westco Pump Div. Mr McNally

H L McNally

joined the company over 16 years ago and was formerly assistant sales manager of the division.

AMERICAN INDUSTRIAL LABS, Empire State Building, New York, N.Y., E R Edwards, manager, has been formed to provide consulting service on industrial water problems, including boiler-feed-

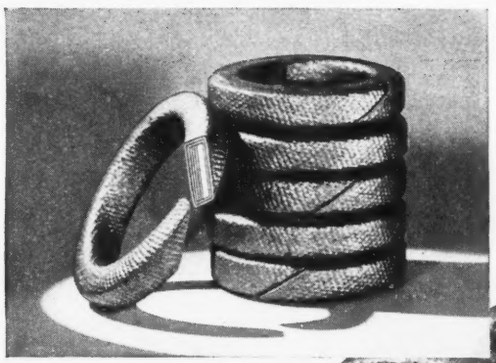
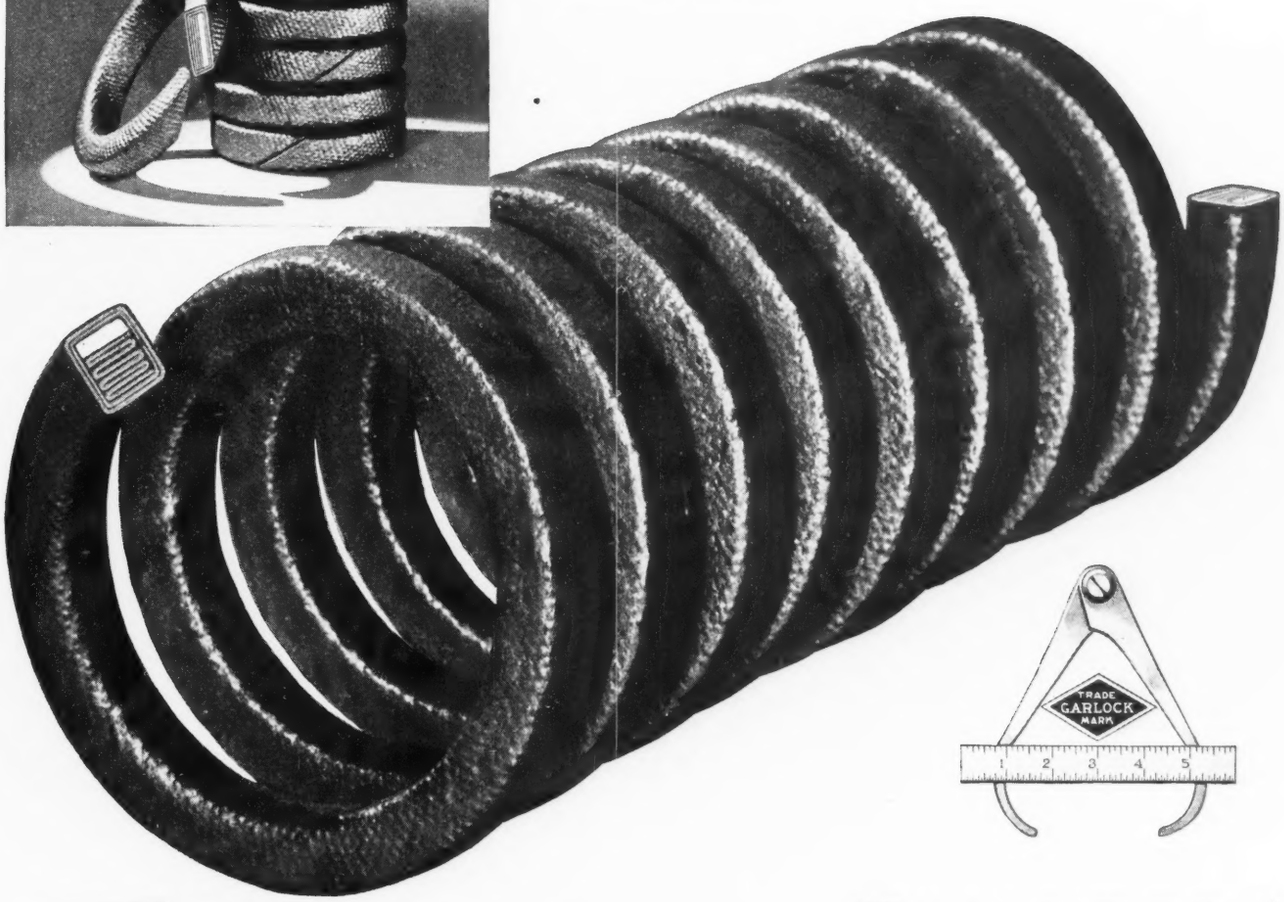


Photo at left shows Garlock 200 Rings. Illustrated below is Garlock 150 Spiral. Also furnished in coil form (Garlock 125).



This Packing Packs a PUNCH!

GARLOCK 150 High Pressure Steam Packing "has the stuff" for long, dependable packing service. It is specially constructed to withstand high pressures and high temperatures.

GARLOCK 150 is recommended for use on steam engines, pumps, compressors, expansion joints and any other service against steam pressures up to 300 pounds. Try GARLOCK 150 in your plant!

THE GARLOCK PACKING CO., PALMYRA, N. Y.
In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

GARLOCK 150

MAKING HISTORY IN HISTORIC RICHMOND!
Richmond, Va. Standing before the Assembly in this great city 116 years ago, fiery Patrick Henry made history with his ringing words . . . "Give Me Liberty Or Give Me Death!"
Today in tall buildings in modern Richmond, Macwhyte Special Traction elevator cables are also making history.
"Longer, better service than any cable I've ever used . . ."
"Although I give out recabling by contract I specify and insist on Macwhyte . . ."
You hear statements like these from building owners, managers, and engineers. They tell you why Macwhyte Special Traction is widely used here, as everywhere.
And ready now, to make new low-cost-per-car-mile history is the new "Hi-Speed" Special Traction. Made from special steel wire, "Hi-Speed" is extra flexible, PREformed, and has unusual traction. It gives you what you want most: smooth operation at low-cost-per-car-mile.
Try a set of Macwhyte "Hi-Speed" cables and prove to yourself the low-cost-per-car-mile they can give you. Quick delivery from Macwhyte Distributor stocks.
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Hi Speed
MACWHYTE SPECIAL TRACTION
PRE-FORMED FOR Elevator Cable BEST PERFORMANCE

CRANE ROPES
Put MONARCH WHYTE STRAND PREformed CRANE ROPES to work—for safety and economy. Ask for details.
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Try this new technique of heavy lifting. Your loads will be handled safely and easily. Send for literature on ATLAS Braided Wire Rope Slings.
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water treatment. Service includes analyses, detailed instructions, source of chemical supply, consulting privileges. Company does not sell chemical treatment, but advises where necessary raw chemicals can be purchased direct from producer.

CINCINNATI RUBBER MFG CO, Cincinnati, Ohio, announces appointment of John Flocker & Co, 644 Grant St, Pittsburgh, as distributors of company line for Pittsburgh and surrounding counties.

ELGIN SOFTENER CORP, Elgin, Ill., announces appointment of Allan T Shepherd Co as representatives in states of Virginia, North and South Carolina. Addresses of Shepherd Co are 411-12 Tenth St Bldg, Richmond, Va., and 215 Providence Rd, Charlotte, N. C.

UNION IRON WORKS CO announces appointment of Harry T Porter Co as sales agents in Cincinnati district. Headquarters for Porter Co is in Union Central Bldg. For Western New York and Buffalo territory the sales agent is George G Van Tuyl.

NATIONAL SUPPLY CO, SUPERIOR ENGINE DIV, announces opening of Boston office at 250 Stuart St, with R P Bolster, manager of New England district, in charge.

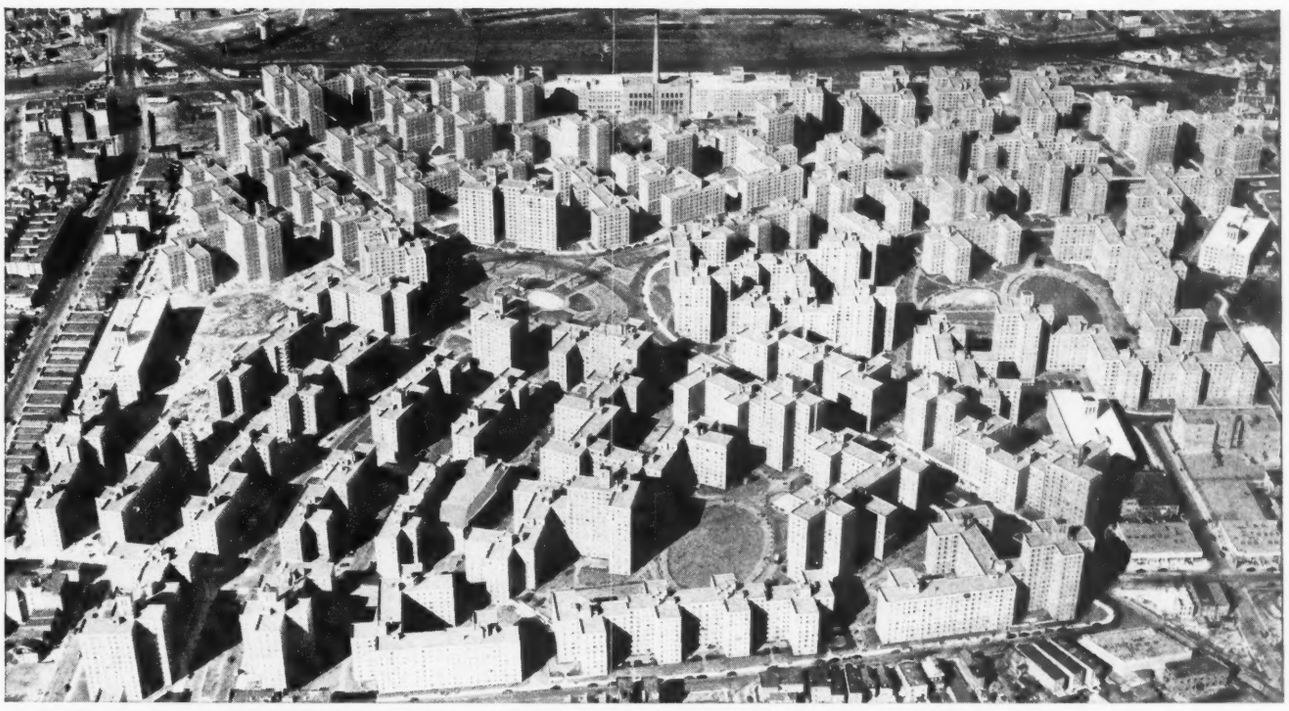
AMERICAN K A T CORP announces opening of Philadelphia office under supervision of Frank C Coe. Office will be at Commercial Trust Bldg, Fifteenth & Market Sts.

William H Pratt Honored

Chosen the outstanding New England engineer of the year, William H Pratt, retired consulting engineer of the Meter Div, General Electric Co, Lynn, Mass., Works, became the first recipient of the "New England Award" at the annual banquet of the Engineering Societies of New England, Inc, April 30. Mr Pratt, recognized as an authority on electrical measurement, has 76 patents to his credit. His first patent, obtained in 1897, was on a watthour meter. Many of his inventions were fundamental, while others covered improvements and new designs on watthour meters, demand meters, and electrical-measuring instruments of all types. He retired from General Electric last year, after 45 years of continuous service.

The "New England Award," pre-

PARKCHESTER



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PEABODY BURNERS

on the "Firing Line"

When the Metropolitan Life Insurance Company planned the World's largest housing development in the Bronx, New York, comprising 58 buildings to house and service 12,200 families, the engineers selected only the most up-to-date and efficient equipment for its large heating plant...

Which explains why Peabody Wide Range Mechanical Atomizing Oil Burners with the Peabody Patented Constant Differential Pump System were selected for firing the four boilers. Sixteen burners in teams of 4 per boiler, normally operate over a range from 10,000 to maximum capacity of 135,000 lbs. of steam per hour per boiler, without change of atomizer tips or cutting burners in and out of service.

Only the oil actually burned is delivered to the boilers. No hot oil is returned to the tanks or service pumps. The quality of atomization is maintained uniformly high over the entire range of operation.

Follow the lead of the exacting engineers who built the Parkchester power plant — SELECT PEABODY.

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PEABODY LIMITED, LONDON

One of the two Schramm Direct Drive Stationary Compressors supplying air for miscellaneous production requirements.

A LOT OF AIR—at low cost—IN A LITTLE SPACE

This modern Schramm unit—supplying compressed air in a large Industrial plant — is a duplicate of one furnished this nationally known manufacturer three years ago.

Note the compact size of the unit by comparison with the man standing by. Smooth, vibration-free performance is also evident from the sharpness of the photograph taken while the compressor was running at full speed supplying 300 cu. ft. of air.

With Schramm Stationary Air Compressors, the required amount of air can be supplied easily and economically when and where it is needed at savings in power, piping and foundation work. These units are available in a wide range of sizes with motor, V-belt or direct drive.

Send for Bulletin No. 3907 giving detailed information.

SCHRAMM COMPRESSOR VALVES

Positive valve action of Schramm Compressors is assured by mechanical intake valves. This feature, which contributes trouble-free performance by providing exact timing also assures delivery of air at the rated capacity of the compressor.

SCHRAMM, INC., WEST CHESTER, PA.

SCHRAMM UTILITY STATIONARY AIR COMPRESSORS

sented for the first time this year, is to be made not more than once a year to a living engineer, resident in New England, who by outstanding achievement has merited recognition of his work and character by his fellow engineers of the New England states.

ASHVE Meeting Set For San Francisco, June 16

San Francisco will welcome the American Society of Heating and Ventilating engineers for its semi-annual meeting during the week of June 16. The Palace hotel has been selected as headquarters and plans for the meeting are being developed by the Committee on Arrangements, of the Society's Golden Gate Chapter. The reasons for the trip to the Pacific Coast are threefold, according to the ASHVE: first, for the semi-annual meeting of the society; second, for the 52nd Annual Convention of the Heating, Piping and Air Conditioning Contractors National Association; and third, the Pacific Heating and Air Conditioning Exposition.

Heating Exposition January 26-30, 1942

General announcement has been made of the 7th International Heating and Ventilating Exposition, to be held January 26-30, 1942, in the Commercial Museum, Philadelphia, Pa., under the auspices of the American Society of Heating and Ventilating Engineers. At the same time the society will hold its 47th annual meeting. The exposition is under the management of the International Exposition Co, of New York, of which Charles F Roth is president.

TVA Orders Third Turbine from GE

Tennessee Valley Authority has ordered a third turbine-generator from the General Electric Co for the Watts Bar steam power plant, near Chattanooga, Tenn. Like the first two units ordered last year, it will be rated 60,000 kw and will use 850 lb, 900 F steam. The Air-cooled generator will operate at 1800 rpm.

The Watts Bar station represents the first expansion by TVA of its power-generating facilities by other than hydroelectric development, and is part of a $65,800,000 program to provide power for national defense needs in this area. The first two units are expected to be installed at Watts Bar by next January, with the third unit being put in by the end of 1942.

TO CUT ROPE COST...

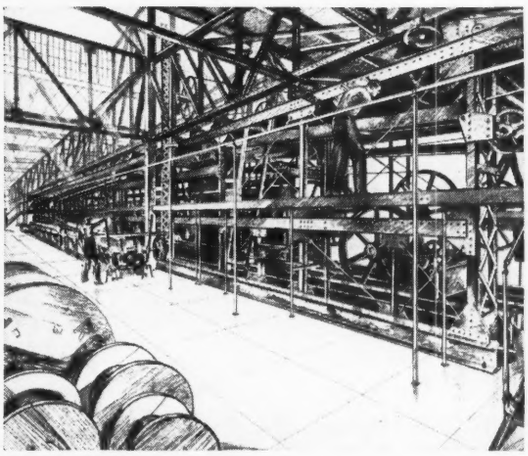
KEEP YOUR EYE ON THE ROEBLING "4"

PROFIT FROM *all 4* IN ROEBLING ROPE

1 UNUSUAL ORGANIZATION
2 EXCEPTIONAL FACILITIES
3 AGGRESSIVE RESEARCH
4 100 YEARS EXPERIENCE

The Roebling "4" combine to give you the one thing above all that counts in wire rope service. And that is — utmost *overall* rope safety and minimum *general average* rope operating cost — economy based on your ropes *as a whole.*

ROEBLING
"Traction Steel"
ELEVATOR ROPE



WIRE ROPE HIDES NO SECRETS HERE!

This wire rope fatigue machine is an outstanding example of Roebling's aggressive research and exceptional facilities.

It is the largest and most highly developed wire rope fatigue machine in existence, designed by Roebling for use in studying rope characteristics. With this machine is carried on a never-ending search into the wearing and fatigue qualities of wire rope under various bending and tension conditions.

ROEBLING 1841 1941 100th ANNIVERSARY

JOHN A. ROEBLING'S SONS COMPANY TRENTON NEW JERSEY

Branches in Principal Cities Export Division: 19 Rector St., New York, N.Y., U.S.A. Cable Address: "Roebling's", New York

We like the general approval of Raybestos-Manhattan packings, but the applause we appreciate most comes from the men who know—the boys who are responsible for clean, smooth, economical shop performance. They specified R/M packings in the first place because it was the best known name in asbestos, with 40 years' experience in industrial control. But they specify it now—and recommend it today on pure performance. They know that R/M packings are the complete line (without duplicates) that has smoother control, needs less attention, and holds wear to the absolute minimum. Join them. Let R/M packings whip your power into line. You'll find it pays.

Invitation: Own your personal copy of this complete, condensed, cross-indexed and photographic R/M catalog. You'll pick the right packing in less time, and you'll get quick delivery. Write for a free copy, or ask your nearest R/M distributor.

INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
Makers of Packings for Every Industrial Use
BRIDGEPORT, CONN. MANHEIM, PA. NORTH CHARLESTON, S. C. PASSAIC, N. J.

New Bulletins

BOILERS AND ACCESSORIES

1 BOILER SEALING RINGS—George P Reintjes Co, 2517-19 Jefferson St, Kansas City, Mo. 4-page folder illustrates and describes Reintjes drum-sealing rings, used to prevent upper side wall infiltration around boiler drums. Typical side-wall installation shown, and description of insulated and air-cooled wall included.

2 STOKER—Iron Fireman Mfg Co, 3015 West 106 St, Cleveland, Ohio. Novel bulletin gives visual presentation of Iron Fireman spreader stoker, and includes in text matter: the company behind the product; the pneumatic spreader principle; feeding and conveying the coal; combustion in the furnace; and other brief articles.

3 FIRE BRICK—A P Green Fire Brick Co, Mexico, Mo. "Modern Fire Brick Manufacture" is illustrated book which shows with dramatic photographs story of production of fire brick as carried on in company plant.

4 DUST COLLECTORS — American Foundry Equipment Co, Mishawaka, Ind. 12-page booklet tells reasons why dust conditions in plant should and can be properly controlled with American dust-collecting equipment. Three types described: "Dustube" dust collector, high-efficiency cyclone dust collector, and wet disposal unit.

5 FIREBRICK — Botfield Refractories Co, Swanson & Clymer Sts, Philadelphia, Pa. 4-page folder gives numerous applications for Adamant firebrick cement, presents instructions for using same, and includes testimonials by satisfied users.

6 HEAT EXCHANGERS—Heat Transfer Products, Inc, 90 West St, New York, N. Y. Bulletin No. 101-A describes company's "Leverlox" design for heat exchangers, both shell and tube type, and also covers new type atmospheric evaporator, incorporating self-scaling tube and other features.

7 REFRACTORY—Refractory & Insulatory Corp, 381 Fourth Ave, New York, N. Y. 2-page leaflet describes "Chromio," plastic-chrome ramming refractory. Advantages and working qualities of refractory given, and extensive applications listed.

8 BOILERS—Kewanee Boiler Corp, Kewanee, Ill. Circular No. 97.80k is excerpt from general catalog, and shows Type C boilers, with specifications tabulations and diagrams. Also covers boilers installed on typical jobs singly and in batteries with mechanical firing.

9 OIL BURNERS — National Airoil Burner Co, 1284 E Sedgley Ave, Philadelphia, Pa. 8-page illustrated bulletin shows numerous applications of burners in industry, steamboats, public buildings, schools and churches. Other oil- and gas-burning equipment listed, with pictures.

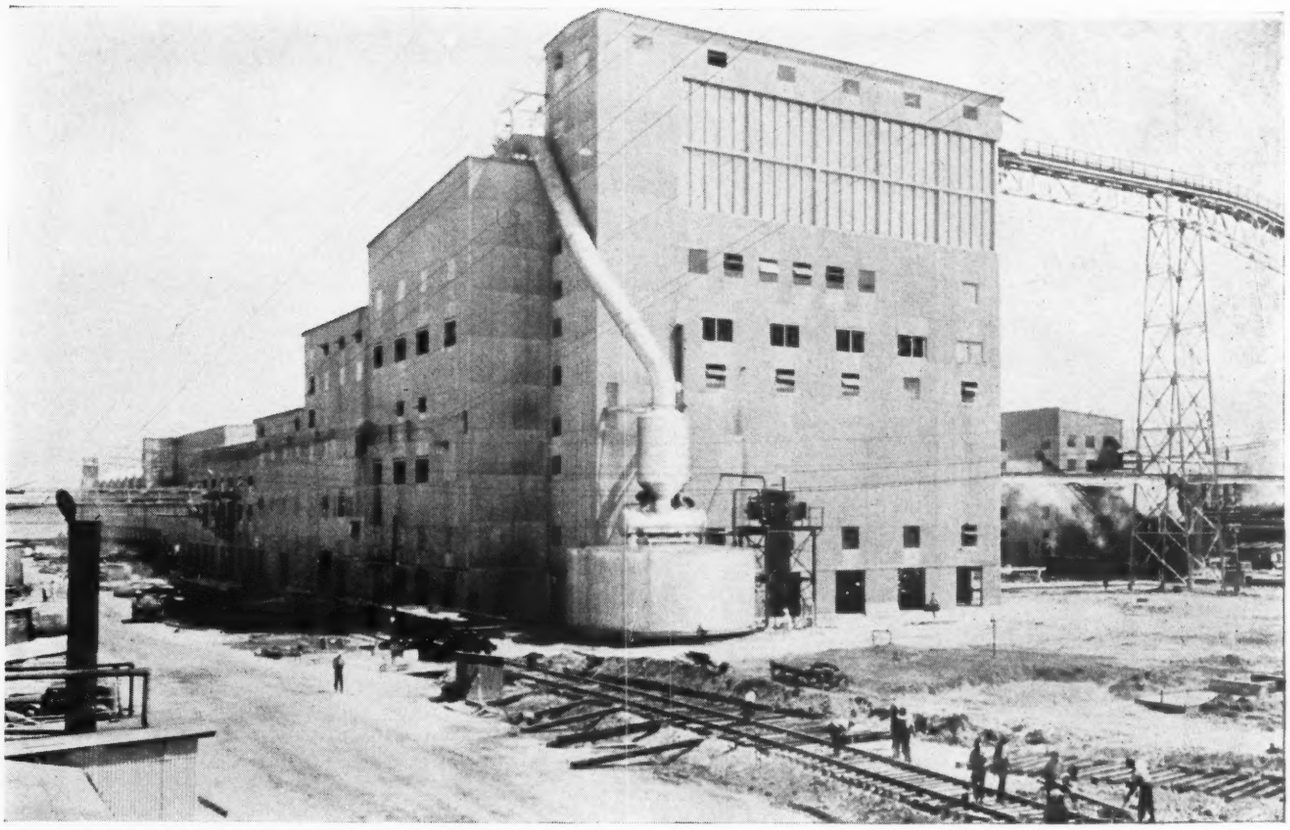
10 STOKERS—Canton Stoker Co, Andrew Place, Canton, Ohio. Illustrated catalog describes Canton Lo-Set Ram Feed Stokers, used for smaller installations where space is limited. Typical installations pictured.

ELECTRICAL EQUIPMENT

11 CONNECTORS—Burndy Engrg Co, 459 East 133rd St, New York, N. Y. 64-page data book describes complete line of solderless electrical connections for cable, flat-bar and tubular conductors and gives technical data on insulated cable and flat copper bars. Included are tables of sizes, dimensions, weights and prices of each design of terminal.

12 CIRCUIT BREAKER—I T E Circuit Co, Philadelphia, Pa. Single-page leaflet describes and illustrates Type K A air circuit breaker. Advantages and features presented.

13 FUSE CUTOUTS — Schweitzer & Conrad, Inc, 4435 Ravenswood Ave, Chicago, Ill. 32-page bulletin 215 describes complete line of S & C fuse cutouts, including open and closed types, as well as light, medium, and heavy-duty cutouts.



"EXCELLENT SERVICE"

says—WEST VIRGINIA PULP and PAPER CO.

West Virginia Pulp and Paper Co.—one of the largest producers in its field—has had plenty of experience with gate valves. It is summed up by A. J. Driscoll, of the Engineering Department, who writes "Darling Valves and Hydrants have given excellent service since 1909, when they were first installed at our mills."

Darling *quality* — subject to constant checking at the delivery end of the production line — begins with tangible construction advantages.

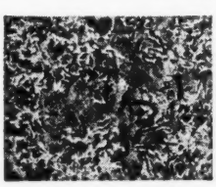
"Dense metal" tells the story—metal that is more adaptable to machining, takes a smoother thread, and is free from flaws or shrinks. It is a result of special care in foundry technique, melting processes, and molding practice—including frequent tests at every stage of development.

DARLING VALVE & MANUFACTURING CO.

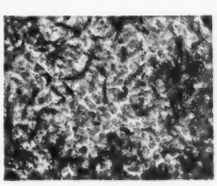
WILLIAMSPORT, PA.

Representatives in:

New York Philadelphia Houston Toledo Pittsburgh
Huntington, W. Va. McPherson, Kan.



In ordinary cast iron (left) flaws sand-holes often occur. Darling "dense metal" (right) is an atomic mass, free from porosity, flaws, or checks.



DARLING

DENSE-METAL GATE VALVES

BALDWIN-HILL
No. 100
Pipe Covering

B-H No. 100 Pipe Covering 3" thick on Underground Steam Line finished with 45 lb. Roofing Felt.

Effective up to 1000° F., it is particularly adaptable to long runs of steam lines, either underground or overhead. B-H No. 100 Pipe Covering is fabricated of high temperature and moisture resistant B-H Black Rockwool, the long fibres being held in place with expanded metal lath on the outside and strips of the same material on the inside. It provides maximum insulating efficiency, meeting the most rigid engineering requirements. Furnished in thicknesses from 1" to 4" to fit pipe sizes ranging from 2" to 30".

BALDWIN-HILL CO., 575 Klagg Ave., TRENTON, N. J.

Yes! I'm interested in B-H No. 100 Pipe Covering.

☐ *Send Sample* ☐ *Send Literature* ☐ *Send Representative*

☐ *Send Catalog showing complete line of Heat Insulations*

NAME..... TITLE.....

ADDRESS.....

COMPANY.....

CITY..... STATE.....

stem globe type, rotary-stem globe type, butterfly-type, pilot-operated, 3-way and special valves.

42 VALVES—R S Products Corp, Wayne Junction, Philadelphia, Pa. 12-page bulletin No. 8-B features late models and wafer-type butterfly or blast-gate valves for control of air, gas, steam and liquids. Contains data and illustrations for both manual and automatic control by means of air and electric motors, solenoids, air and hydraulic cylinders.

43 VALVES—Hancock Valve Div, Manning, Maxwell & Moore, Inc, Bridgeport, Conn. 8-page bulletin features Hancock Superfinished "500 Brinell" Bronze Valves. Describes application of superfinish operation to manufacture of bronze valves, and covers recently developed Hancodur stems and bonnets used in new valves.

44 VALVES—Homestead Valve Mfg Co, Coraopolis, Pa. 4-page bulletin covers Homestead valves in various types, and their application to ships and industry, stressing their use in national defense.

45 PIPING—American Locomotive Co, Alco Products Div, 30 Church St, New York, N. Y. 4-page bulletin tells advantages and facilities of company and company products. Various examples of pre-fabricated piping shown.

46 TRAP—W H Nicholson Co, 12 Oregon St, Wilkes-Barre, Pa. Single-page bulletin shows Nicholson weight-operated trap in cross-section, illustrating different parts and giving applications.

47 VALVES—American Chain & Cable Co, 929 Connecticut Ave, Bridgeport, Conn. Wire-bound catalog contains all pertinent information regarding cast-steel valves and fittings. Standard symbols and valve markings included, and typical chemical compositions and physical properties of valves given.

PRIME MOVERS

48 DIESEL ENGINES—Lorimer Diesel Engine Co, Oakland, Calif. 4-page, 2-color folder illustrates and describes various types of Lorimer diesels, giving applications of engines in different parts of the world. Stationary, marine and natural-conversion engines covered.

49 DIESEL MODERNIZATION — Fairbanks, Morse & Co, 600 S Michigan Ave, Chicago, Ill. 12-page Bulletin "Modernizing Your Diesel" tells F-M diesel owners how they can modernize their present diesels with change-over parts. Photographs and drawing show how diesels look before and after modernization, while testimonials add to records showing advantages in change-over.

49A DIESELS — R H Sheppard Co, Hanover, Pa. 4-page folder gives features, advantages, and comparative costs of Sheppard diesel-electric package plants. Engine specifications of Model 6 included.

PUMPS

50 CENTRIFUGAL PUMP—De Laval Steam Turbine Co, Trenton, N. J. 4-page paper is reprint from POWER of article, "Adjusting Centrifugal-Pump Speed Cuts Operating Costs," and is divided into two parts. First has to do with insertion of variable-speed coupling between motor and pumps, while other deals with insertion of coupling between several pumps in unit.

51 PUMPS—Allis-Chalmers Mfg Co, Milwaukee, Wis. 4-page Bulletin No. B6153 gives over-all dimensions, applications and selection table for engine-driven centrifugal pumps.

52 PUMPS—Lawrence Machine & Pump Corp, 371 Market St, Lawrence, Mass. Bulletin 207-2 describes surry and sludge pumps, adapted for handling slurries containing solids in suspension, with wide application in chemical plants, and industrial plants.

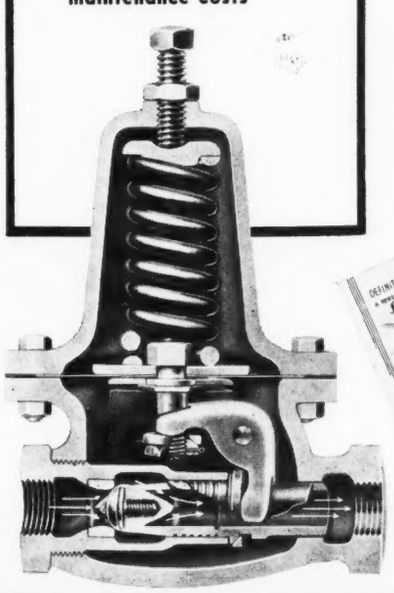
53 PUMPS — Worthington Pump & Machinery Corp, Harrison, N. J. Bulletin W-350-B7 describes centrifugal process pumps, Types CV, CVX, and CW, for chemical and allied industries.

54 PUMPS—Nash Engrg Co, South Norwalk, Conn. 8-page bulletin No. 336 gives construction details, capacity curves, and illustrations of Nash glass pump, a centrifugal of "Pyrex" brand,

Check

EVERY ONE OF THESE VALVE *Benefits* IN YOUR OWN PLANT . . .

- maximum capacity when needed most
- accurate pressure control under toughest working conditions
- trouble-free service
- smooth operation
- tight closure
- accurate regulation
- speedier production results
- elimination of failures
- constant delivery pressure
- cost saving operation
- no service attention
- no spoilage
- practically zero in maintenance costs

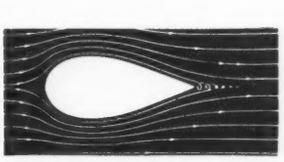


CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVE

It costs you nothing to check up on these benefits

Put a CASH STANDARD Streamlined Type 1000 Valve to the test for 30 days — you can do it FREE — find out what its performance means in dollars and cents savings — see how flow, that is not broken up by valve stems, springs, or other parts, adds immeasurably to better all around results — after 30 days a bill is sent to you — you either pay the bill or return the valve to us at our expense. Putting this test off may be losing valve money for you.

NONE OF THIS TURBULENCE



GIVES THIS FLOW PATTERN

If you want full details on the STREAMLINED "1000" *Valve, send for bulletin 1000.*

This bulletin gives you complete design and operating facts. Steam, air, and water capacity charts are shown —they enable you to determine precisely how much fluid any size Streamlined Valve will deliver under your exact pressure conditions—for steam, air (and other gases), water (and other liquids).

Straight Line Flow
FROM INLET TO OUTLET

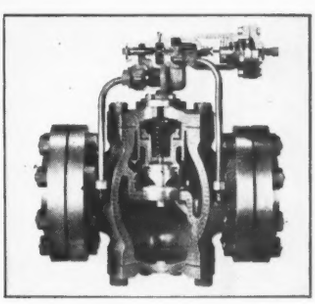
A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

A CASH STANDARD "GET ACQUAINTED" COLUMN

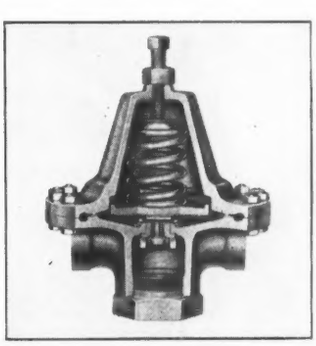
Question: "Don't you people make anything besides that Streamlined Valve you talk about so much?"

Answer: "Yes Sir; we do! And we propose to picture one or two of them here each time."



Cash Standard Type 11 Regulator, for use with water, air or any gas or oil that is non-corrosive. Pressure to actuate pilot valve may come from any source; and be as high as 1500 lbs. Variety of uses, notably as condenser water regulator.

Inlet pressure up to 600 lbs.; outlet pressure up to 250 lbs. Bodies; iron, bronze, steel. Trims; iron, bronze, stainless steel. Screwed, flanged, or ammonia type ends. Sizes: 2" to 12".

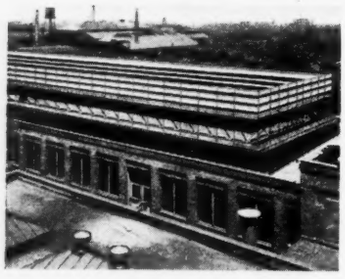


Cash Standard Type 8871 Pressure Reducing Valve; for use with liquids—especially dirty liquids, like Bunker C fuel oil for example. No sliding fits: inner valve bolted to diaphragm for positive movement.

Initial pressure up to 250 lbs., reduced pressure up to 200 lbs. Bodies; iron, bronze or steel. Renewable inner valve and seat ring, stainless steel. Sizes: ½", ¾", 1".

Get Free Bulletins on Above . . . Write to
A. W. CASH COMPANY
DECATUR, ILL.

FOR COOLING CONDENSING and CIRCULATING WATER



Typical Roof Cooling System with Louvre Fence.

Use

SPRACO

Low-Cost

COOLING SYSTEMS

Section of Typical Spraco Cooling System at Ground Level.

For rehabilitating power plants in connection with the Defense Program, Spraco Cooling Systems are the simplest, most economical and satisfactory method of cooling the water used in condensers, and other equipment where conservation of the water supply is of primary importance.

A Spraco Cooling System can be installed on the ground or on the roof of a building. Roof systems are provided with a patented louvre fence to prevent spray drift.

Spraco engineers are prepared to estimate the cost of revamping or increasing the capacity of existing equipment as well as designing complete new systems.

Write for Cooling Systems Bulletin.

SPRACO AIR WASHERS

We are prepared to recondition any existing Spraco Air Washer and shall be pleased to quote on replacement eliminator plates, nozzles or other parts as well as on complete new equipment. Write for Air Washer Bulletin.

SPRAY ENGINEERING CO.

120 Central Street, Somerville, Mass.

heat-, shock-, and acid-resistance glass. Approximate dimensions and pipe sizes included.

WATER TREATMENT

55 WATER TREATMENT—D W Haering & Co, Inc, Chicago, Ill. 8-page bulletin entitled "The Solution to Your Problem" describes latest developments in proportioning and sampling equipment. Well-illustrated with diagrams, installation photographs and tables.

56 WATER TREATMENT — American K A T Corp, 122 East 42nd St, New York, N. Y. 8-page folder presents organic colloidal principle of water treatment, problems involved in use of inorganic chemicals, and trend in modern feedwater treatment practice, as well as advantages of K A T treatment, what it does, and some laboratory reports on product.

57 WATER TREATMENT—American Water Softener Co, Lehigh Ave & Fourth St, Philadelphia, Pa. 2-page folder illustrates and describes different types of mobile purification units made by company. Shows and describes Model A, mounted on skids; Model B, mounted on trailer; and Model C, mounted on truck.

OTHER EQUIPMENT

58 HYDRAULIC EQUIPMENT—Blackhawk Mfg Co, Milwaukee, Wis. Catalog No. 41H describes and illustrates complete line of hydraulic equipment, including jacks, pipe-benders, etc.

59 WROUGHT IRON—A M Byers Co, Pittsburgh, Pa. 44-page technical bulletin prepared by engineering service dept of company presents story of radiant heating, in connection with Byers wrought iron. Many installations shown, and theory and advantages of panel heating included.

60 COMPRESSORS — Schramm, Inc, West Chester, Pa. 2-page leaflet illustrates and describes different types of portable compressors. Specifications for each model included, together with dimemsions, weights, and prices.

61 PAINT REMOVER — Presto Products Co, 4709 Columbia Ave, Dallas, Texas. 4-page folder lists grades, advantages and applications of Presto paint remover.

62 SYMBOL CHART—Frederick Post Co, Box 803, Chicago, Ill. Wall chart contains 249 engineering symbols, including standard and "hard-to-find" items. Sent free only to interested drafting and designing engineers.

63 BRONZE BEARING — Johnson Bronze, 508 S Mill St, New Castle, Pa. 4-page illustrated folder describes new type pre-cast bearing, bronze-on-steel. Tells method of making bearings, which consist of bronze borings firmly bonded to strip steel. Advantages over ordinary bronze bearing cited.

64 BUILDING MAINTENANCE — Flexrock Co, 2377-A Manning St, Philadelphia, Pa, 74-page handbook has technical information for plant managers, maintenance men and superintendents. Shows how to do many odd jobs at lower cost with better results, and presents numerous ideas that save time and money. Non-technically written.

66 FUSES AND OILERS—Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee, Wis. Catalog No. 50 tells how to secure maximum fuse protection, how to remove and replace fuses safely, eliminate poor contact between fuses and clips, and how to lubricate all types of bearing surfaces with visible, automatic oiling devices.

67 WEDGE PRODUCTS—Wedge Protectors, Inc, 9522 Richmond Ave, Cleveland, Ohio. 16-page folder describes complete line of Wedge products, including pipe tubing and casing protectors, tin plugs, chill rings for welding, and sucker rod protectors.

68 AMPCO METAL—Ampco Metal, Inc, 1745 S 38th St, Milwaukee, Wis. Card slide selector quickly and easily determines physical properties and chemical composition of all grades of Ampco metal. Reverse of selector contains table listing general uses of allow by grades.

69 IRON CEMENT—Smooth-on Mfg Co, 568 Communipaw Ave, Jersey City, N. J. 40-page application book is revised edition, including methods of repairing leaks, pipe clamps, loose bolts, etc, and many other varied uses in power plant.

1941 Ended in April for boilers operating on a 3-shift day

Keep them on the line . . . with fewer shutdowns for cleaning and repairs . . . by APEXIOR-coating the tubes and drums today!

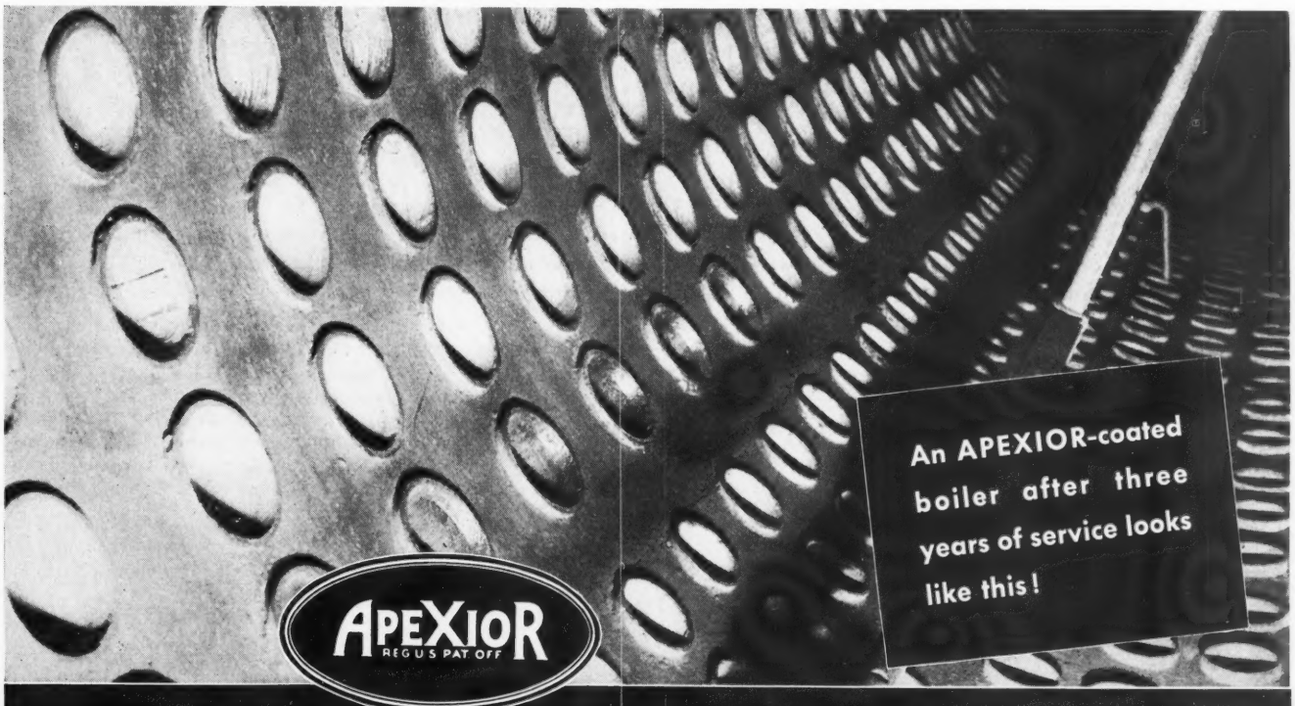
If your plant has jumped from one to two or three shifts in order to step up production, your boilers are operating at a rate that will necessitate shutdowns two or three times oftener!

But an APEXIOR coating will push back the day they must come off the line. APEXIOR, brush-applied to new boilers or old boilers after cleaning, prevents or checks corrosion for up to 3 years without renewal. It also prevents the tight adherence of scale — makes cleaning easier and infrequently required.

All U. S. and Canadian boiler insurance companies recommend APEXIOR. Many plants use APEXIOR to supplement their water treatment, so as to get *utmost* protection.

The time it takes to apply APEXIOR can be reduced almost to the negligible point by use of the recently developed Tube Coating Machine, which also insures a good quality of coverage.

Start now on a standard of boiler maintenance which means uninterrupted service for much longer periods of time. Write now for Bulletin 1290.



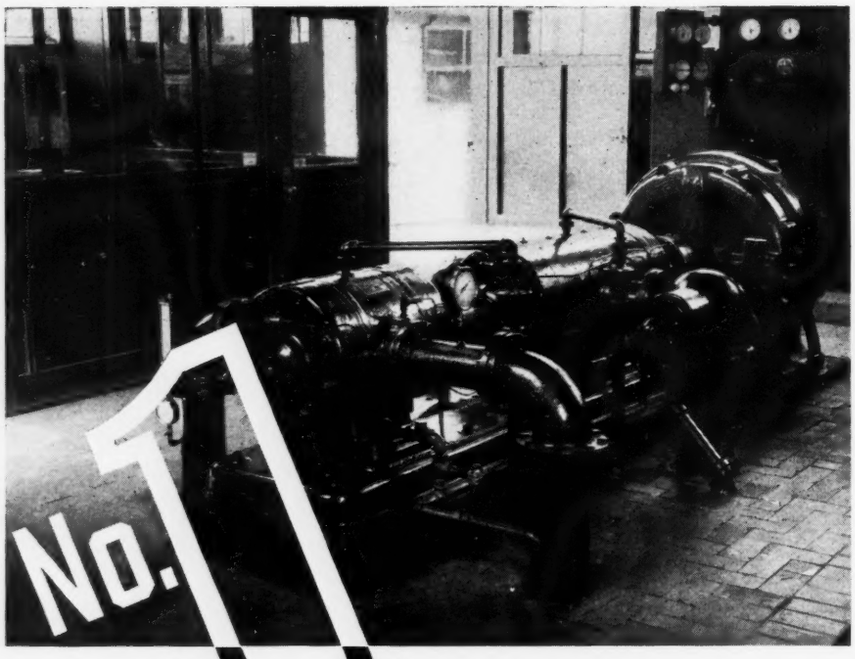
THE DAMPNEY COMPANY OF AMERICA

PROTECTIVE COATINGS FOR STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

HYDE PARK · BOSTON · MASSACHUSETTS

Atlanta Chicago New York Detroit Philadelphia

Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.



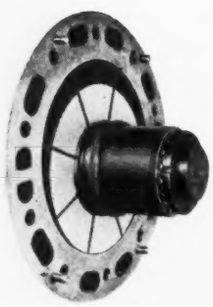
INSTALLED

RESULT: 9 ADDITIONAL FULLERS INSTALLED

BUILT FOR ANY PRESSURE TO 125-LB.

Exceptionally low operating cost, resulting in all-around satisfactory performance of the initial installation, has resulted in the purchase of nine additional Fuller Rotary Compressors by a large eastern steel company. Following installation of this first unit, when compressed air demands increased, more Fullers were installed to best advantage.

This is not an exceptional case . . . many companies have found it pays to practically standardize on Fullers. If you haven't become acquainted with the possibilities of Fullers, *why not do it now?*



FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C-56

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

New Plant Equipment

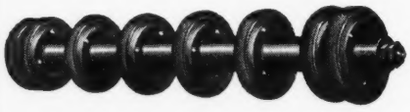
(Continued from page 128)

3-Cylinder Diesel

MODEL 6 SHEPPARD diesel has 3 cylinders, and is 4-cycle full Diesel. Rated at 25 hp at 1200 rpm for continuous full load with fuel consumption rating, under these conditions, not to exceed .50 lb per bhp hr. Features simple Sheppard fuel injection system with self-bleeding injectors, and is equipped with mechanical-flyball governor with adjustable-speed regulation. Complete power unit includes all equipment necessary for full operation where fuel is available. Engine is fitted with power take-off and clutch, radiator, fan, and thermostat to protect cooling system. Also includes filters for both fuel and lube oil, with automatic stop feature, when filter needs cleaning. Other equipment is starting motor generator with overcharge cutout, storage battery and instrument panel with oil-pressure gage, water-temperature gage, and ammeter. *R H Sheppard Co, Hanover, Pa.*

Return Idler

LINK-BELT IDLER consists of from 4 to 12 6-in. diameter rubber-tired rolls suitably spaced and mounted in roller-bearing-equipped steel tube. Individual rolls are made up of renewable extruded rubber tire clamped between two disks held together by round-head bolts. As rubber tire is made split, it can be readily replaced with a new tire when required. Idlers



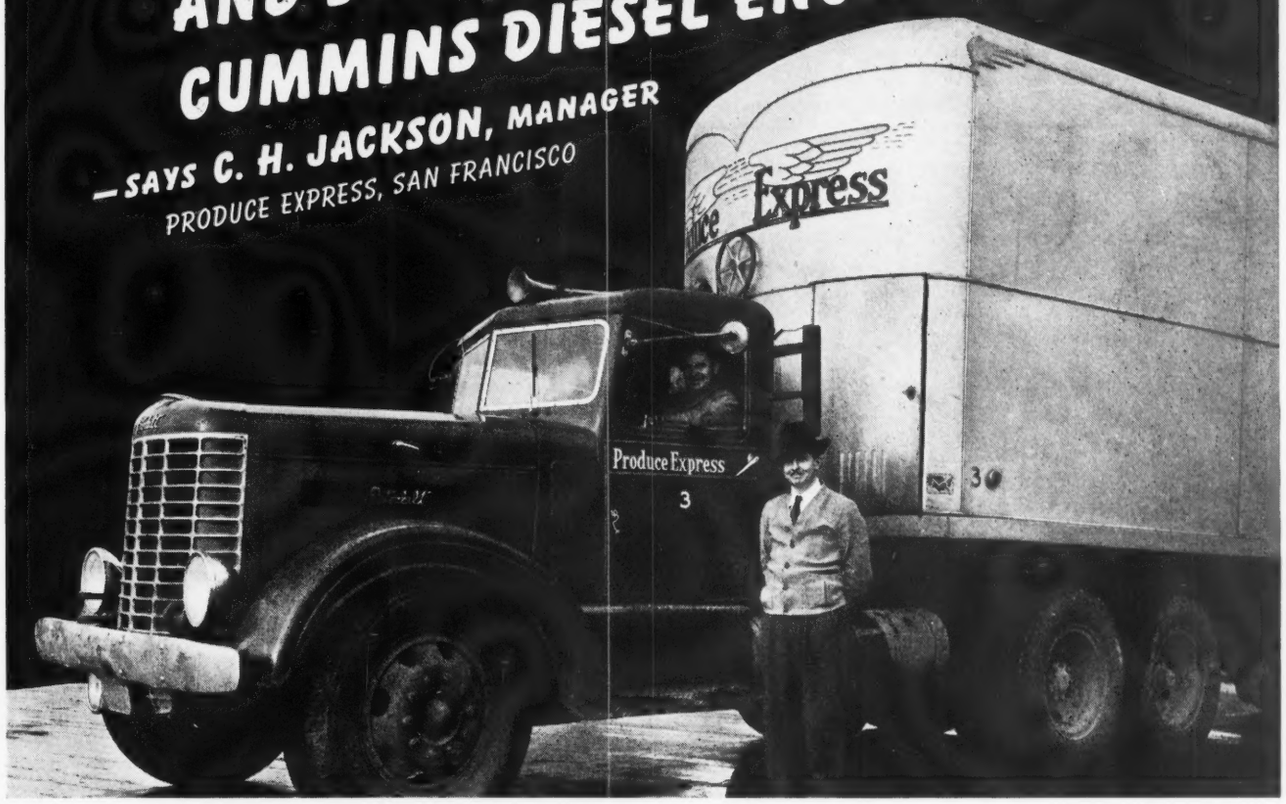
recommended for conveyors handling corrosive, abrasive, wet or sticky materials for following reasons: (1) There is only rubber-to-rubber contact between return idler and underside of conveyor belt, and (2) kneading action of rubber treads keeps material from building up, also helping to break up and loosen ice forming on belt in freezing weather. *Link-Belt Co, 307 N Michigan Ave, Chicago, Ill.*

Micro-Action Valve

"MICRO-BEAN" is for dampening pulsation of boiler plant pump governors, and for eliminating "jitters" of gage hand. Can be installed on pressure line to diaphragm of pump governor for protection of pressure-gage mechanism. It is also effective, according to manufacturer, as protection to any control valve, such as backpressure or reducing regulator, and can be used with sensitive-control instruments subject to pulsating flow. Consists of a solid brass body in which a filter is inserted for

BELIEVE IT OR NOT!—"RING-FREE ENDED CARBON AND SLUDGE PROBLEMS IN THESE CUMMINS DIESEL ENGINES"

—SAYS C. H. JACKSON, MANAGER
PRODUCE EXPRESS, SAN FRANCISCO



They've got to keep rolling on this fast 13-hour refrigerator run between San Francisco and Los Angeles. Cutting down motor overhauls means precious profit when you haul precious perishables. "That's why we're so pleased with Ring-Free," says Mr. Jackson. "Our carbon and sludge problems have been eliminated. Instead of overhauling every 60,000 miles we now go 100,000 miles and more." See for yourself how Ring-Free actually removes carbon and cleans the motor. See how Ring-Free saves on fuel... because it reduces motor friction fast. Call the Macmillan Man for proof... or write us direct.

MACMILLAN PETROLEUM CORPORATION

50 WEST 50TH STREET, NEW YORK • 624 SOUTH MICHIGAN AVENUE, CHICAGO • 530 WEST 6TH STREET, LOS ANGELES

Believe It or Not! by Ripley
REG. U. S. PAT. OFF.

THE 1-2-3 OF RING-FREE

HERE'S WHAT HAPPENS:
1. IT MAKES YOUR MOTOR RUN SMOOTHER
2. IT GIVES YOU MORE MILES PER GALLON OF GASOLINE
3. IT SAVES WEAR AND REPAIR

HERE'S WHY:
1. IT REMOVES CARBON
2. IT CLEANS THE MOTOR
3. IT REDUCES FRICTION FAST BY THOROUGH LUBRICATION!

P.S.—AND IT'S 100% PURE OIL!

—as drawn by Ripley in Life, Collier's, Time

MACMILLAN
RING-FREE
MOTOR OIL

* Reg. U. S. Pat. Off.

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ALLPAX

THE PACKING THAT "PACKS ALL"

The ONE packing for ALL stuffing boxes

You don't have to carry a lot of different packings for different purposes when you use ALLPAX. This universal all purpose packing—made in square cross section for easy fitting—can be used for any and all stuffing boxes—for any fluid or pressure. One size fits all sizes of stuffing boxes.

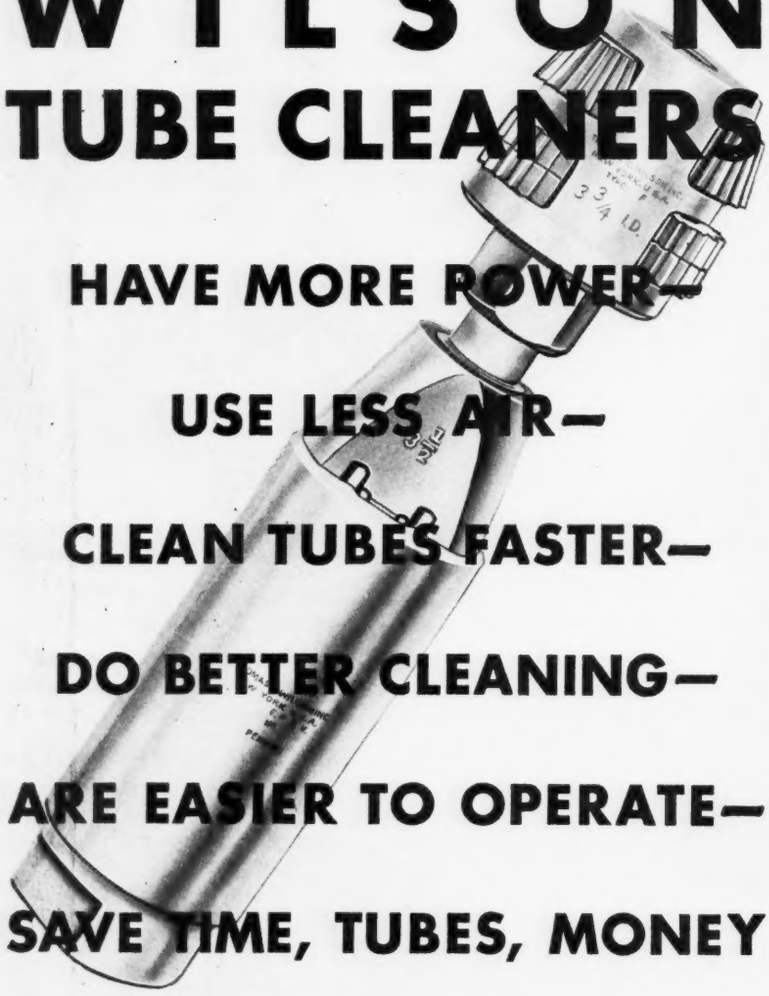
Here's the long wearing, non-hardening packing that holds tight, reduces friction and never scores the rod—economical, efficient time and service proved under all conditions to be the right packing for *your* requirements.

Write at once for full details.

THE ALLPAX CO., INC. Mamaroneck, N. Y.

Distributors Everywhere

WILSON TUBE CLEANERS



HAVE MORE POWER—

USE LESS AIR—

CLEAN TUBES FASTER—

DO BETTER CLEANING—

ARE EASIER TO OPERATE—

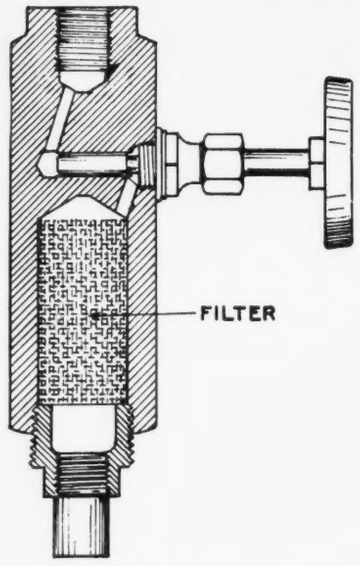
SAVE TIME, TUBES, MONEY

Write for the name of our representative nearest to you or send for a copy of our thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.

PIPE AND TUBE CLEANERS EXCLUSIVELY

47-28 37th Street Long Island City, N. Y.



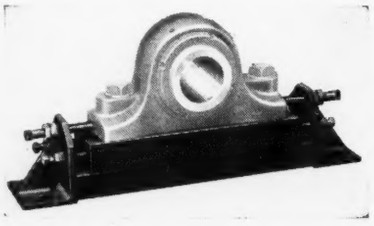
protection from foreign matter. Valve has extremely slight taper so that sensitive control of shut-off is effected. Micrometric control of opening said to enable operator to obtain closest approach to full shut-off, down to the last .0003 of an inch, regardless of line load. Device is universal in application for varied purposes up to 3000 lb pressure and will give any degree of stabilization desired by a turn of valve. *J A Campbell Co, 645 E Wardlow Rd, Long Beach, Calif.*

Pipe Cleaner

CABLE-TYPE PIPE CLEANER, operated through automatic clutch, cleans U-bends, traps, tees, elbows and gate valves, etc. Models range in size from $\frac{1}{3}$ hp to 1 hp, cleaning $\frac{3}{8}$- to 6-in. pipe. Applications include cleaning condenser tubes, feedwater heaters, fire-tube boilers, water-cooled furnaces, air-conditioning units, and gas, oil, and chemical lines. *Pittsburgh Pipe Cleaner Co, Pittsburgh, Pa.*

Base Plates

TYPES A AND B BASE PLATES are of welded steel, tabulated, for mounting pillow blocks of shaft sizes up to 8 in. Type A base plates are for horizontal adjustment only, while type B, illustrated, are for both horizontal and vertical adjustments. Type B consist of welded-steel frame, two cast-iron wedges, and two sets of adjusting screws. One set of screws, by changing relative position of sliding wedges, provides for vertical adjustment of pillow block; other



Designed for UTMOST FLEXIBILITY *Built to* EXACTING STANDARDS

BY using creased bends and super-flexible corrugated tangents, Pittsburgh Piping Engineers designed sufficient flexibility into these 12" hot oil lines to insure safe operation without exceeding prescribed overall height of 16' 6". The uniformity of corrugations, accurate bending and quality welding are characteristic of the exacting standards to which all Pittsburgh Piping and Equipment Company fabrication is performed.

PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD STREET., PITTSBURGH, PA.

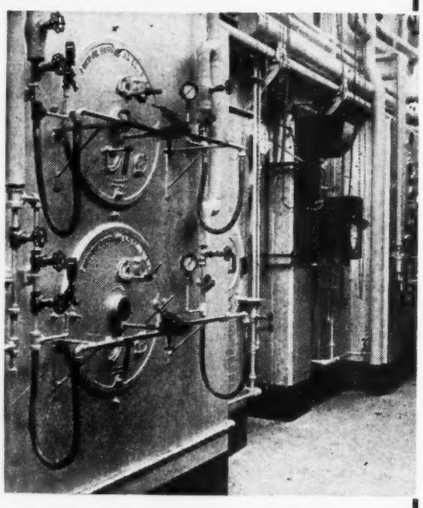
Pittsburgh Piping

CREASED BENDS WITH SUPER-FLEXIBLE CORRUGATED TANGENTS

Enco Burners

. . . . . *for the efficient combustion of all grades of*

OIL, TAR or GAS



Burner Units of Steam or Mechanical Atomizing Types in various sizes with capacity ranges of from 1 to 1000 gals. per hour.

Designed for operation either with or without air register for natural or forced draft.

The ENCO Interchangeable Oil Burner is designed for instant change of atomizer gun for operation by either steam or mechanical (pressure) system or to cover a wide range of capacity. ENCO Oil Atomizers are being applied to various types of standard pulverized coal and gas burner units to provide a dual fuel unit for cold starting or for full load operation when coal or gas is not available or when oil is the more economical fuel.

We have made many installations and would be glad to cooperate with those looking for better operation and assurance against loss of steam output.

Write for Bulletin OB-40 and 37 describing ENCO Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY

75 West St., New York, N. Y.

This

BIG RED BAR

SAVES POWER AND BELTING

To make belts grip better and last longer, just hold end of the big 2" x 8" bar of Dixon's Solid Belt Dressing against the running belt. Perfect for leather, rubber, and composition belts. Contains no graphite. Booklet 0-94.

THESE GRAPH-AIR GUNS MAKE LIFE EASIER 75¢

Use a gun for a thousand and one lubricating and coating jobs around the plant. A squeeze shoots Dixon's Microfyne Powdered lubricating Graphite right where you want it—and there it stays. No drip, no run, no gum. Ideal for locks, hinges, gaskets, etc., etc. "CUB" Gun 10c; "JUNIOR" (4-times larger) 30c; "SENIOR" (6-times larger and refillable) 75c; chute top MICROFYNE eight-time refill can 50c. From your supply house or write for Booklet CG-94.

AND WHAT A HELP THESE ARE . . .

JOSEPH DIXON CRUCIBLE CO.

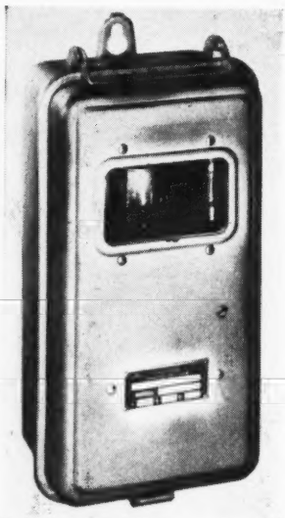
JERSEY CITY, NEW JERSEY

75

set regulates horizontal adjustment. Bearing bolts pass through slotted holes in wedges, and both horizontal and vertical adjustments are limited only by length of slotted bolt holes in bearing itself. *Link-Belt Co, 307 N Michigan Ave, Chicago, Ill.*

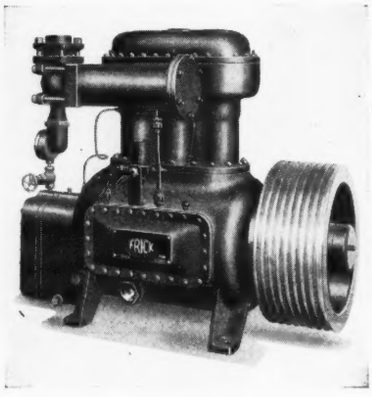
Photo-electric Switch

"SUN-SWITCH" is used to control electrical circuits in accordance with rise and fall of natural illumination. User chooses two lighting levels at which he wishes load switched on and off, and then adjusts calibrated dials to corresponding footcandle readings. Operation from then on is automatic, no resetting being necessary. *United Cinephone Corp, Torrington, Conn.*



Compressors

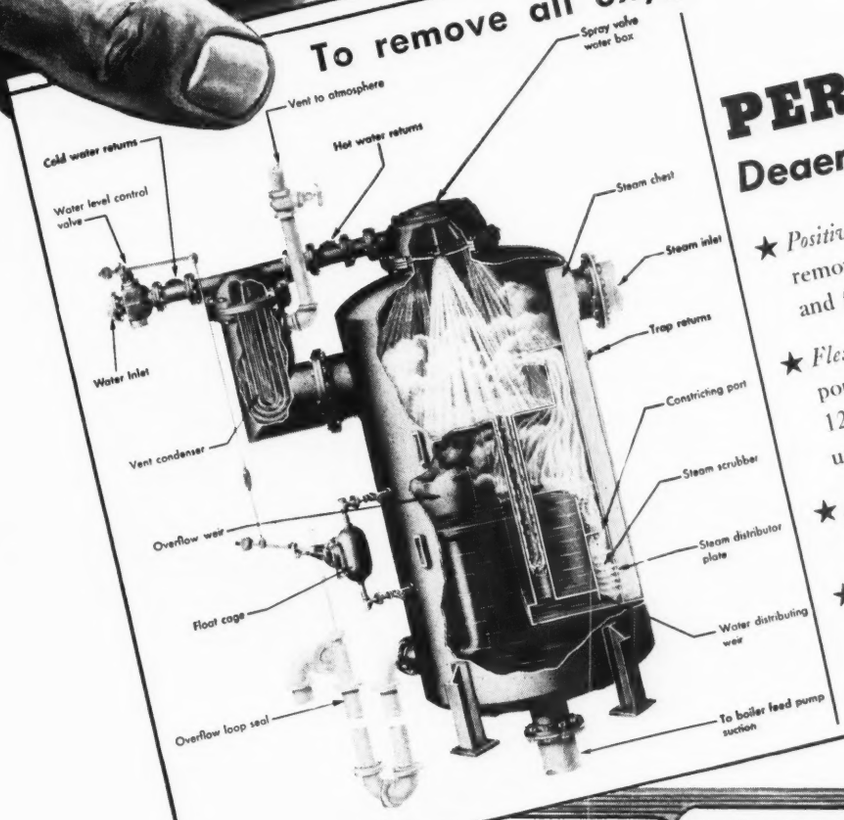
"ECLIPSE" COMPRESSORS designed to give larger capacities in less space and with less weight than in older types. Either one, two or more cylinders can be equipped, if desired, with an automatic oil-operated



unloading device which gives control of capacity of machine in steps or as a unit. Device keeps suction valve in each cylinder so equipped, open until pressure from oil pump raises a plunger and allows valve to close. In this way machine is made to start without load. To control capacity,

CORROSION-PROTECTION

To remove all oxygen and free CO_2—



PERMUTIT* **Deaerating Heater**

★ *Positive protection*—Guaranteed to remove all oxygen (Winkler test) and free CO_2.

★ *Flexible*—Pressures up to 150 pounds or more; capacities from 12,500 to 1,400,000 pounds in use.

★ *Economical*—Utilizes exhaust or bled steam.

★ *Compact*—Available as a complete, independent unit.

BOILER SCALE PREVENTION

SILICA REMOVAL

REDUCTION OF TOTAL SOLIDS

PERMUTIT

PROVIDES TREATMENT TO COVER EVERY BOILER FEED PROBLEM

You want feedwater treatment that fits your individual plant requirements and raw water supply. Permutit can recommend equipment impartially—because Permutit makes every type.

Let Permutit work with your engineers or consultants to plan efficient, economical boilerfeed treatment. Write for free booklet: The Permutit Company, Dept. A, 330 West 42nd Street, New York, N. Y.

*Trademark Reg. U. S. Pat. Off.

WATER CONDITIONING HEADQUARTERS

Save steam *and get* better steam distribution . . .

WITH CRYER STEAM TRAPS

ACCESSIBLE — cover plate and all mechanism removable without disconnecting piping.

POSITIVE ACTION — correct seating insured by free turning ball valve. Quick venting valve eliminates balancing, dribbling.

QUICK VENTING — rapid discharge of air without regard to temperature.

LARGE CAPACITY—baffle plate prevents sudden surges from lifting bucket and closing valve. Quick venting speeds action. Large orifice in valve seat.

LOW MAINTENANCE—stainless steel wearing parts. Ball valve free turning distributes wear. Valve seat easily removed. Cleaning is simple.

EASILY INSTALLED—inlet connection made through bottom or side. No special supports required.

WILL NOT AIR BIND—all air discharged before condensate through automatic mechanical vent.

INTERCHANGEABILITY — parts individually serviced.

COST—quickly repaid in savings and higher efficiency.

GUARANTEE — will discharge condensate at rated capacities. Will operate satisfactorily within limits of pressure and capacity.

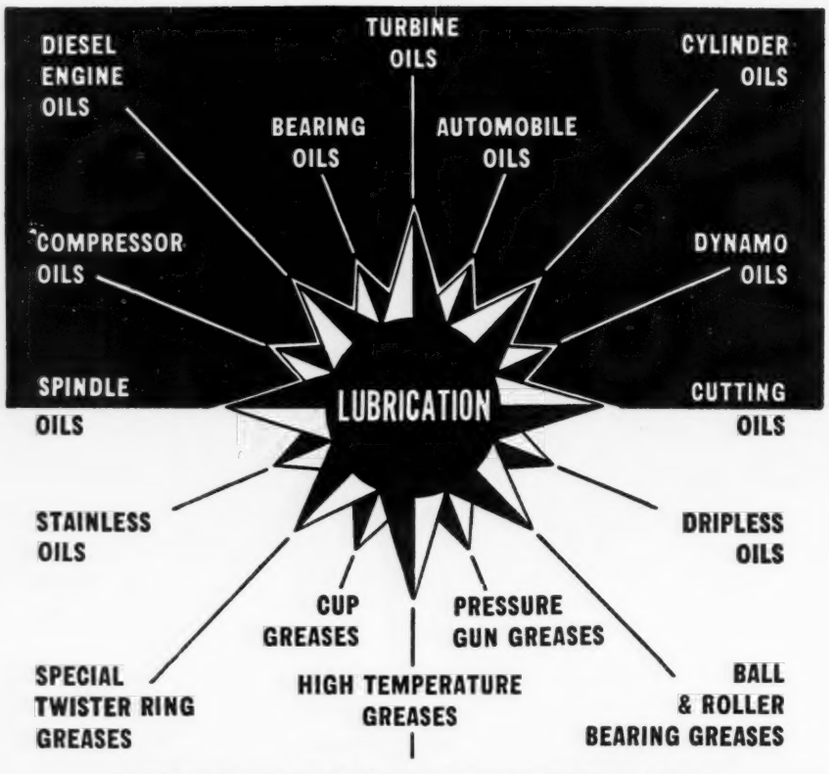
Write for complete details and sizes, capacities available and prices.

We carry all sizes of traps and repair parts of the line formerly known as the J-M BALL Steam Trap.

CRYER TRAP & VALVE CO., INC.

Manufacturers of Steam Specialties for more than 40 years.

366 Madison Ave., New York, N. Y.



PRODUCERS of HIGH GRADE LUBRICANTS SINCE 1874

BORNE SCRYMSER COMPANY

17 BATTERY PLACE • NEW YORK

electric valves operating in conjunction with thermostats or pressure-stats, shut off oil pressure from one or more cylinders at a time, thus allowing suction valves to remain open. Standard equipment with compressor includes V-belt wheel, motor pulley and V-belts, oil-pressure gage, suction-scale trap, suction and discharge service-line valves, safety relief valve, wrenches and tools, piston ring guide, blueprints of compressor and foundations, and foundation bolts. Capacity control feature available on order. *Frick Co, Waynesboro, Pa.*

Power Float and Tamp

POWER FLOAT AND GRID TAMP used in conjuction with Flexrock mastic floors. With power float, drier mixes can be used, which prevent segregation and assure equal distribution of aggregate. Grid tamp is improvement over old methods of floor tamping. Heavy aggregate is more securely anchored as tamp brings fines to the top. Tamp is detachable for easy portability. *Flexrock Co, 23rd & Manning, Philadelphia, Pa.*

Conveyor Belt

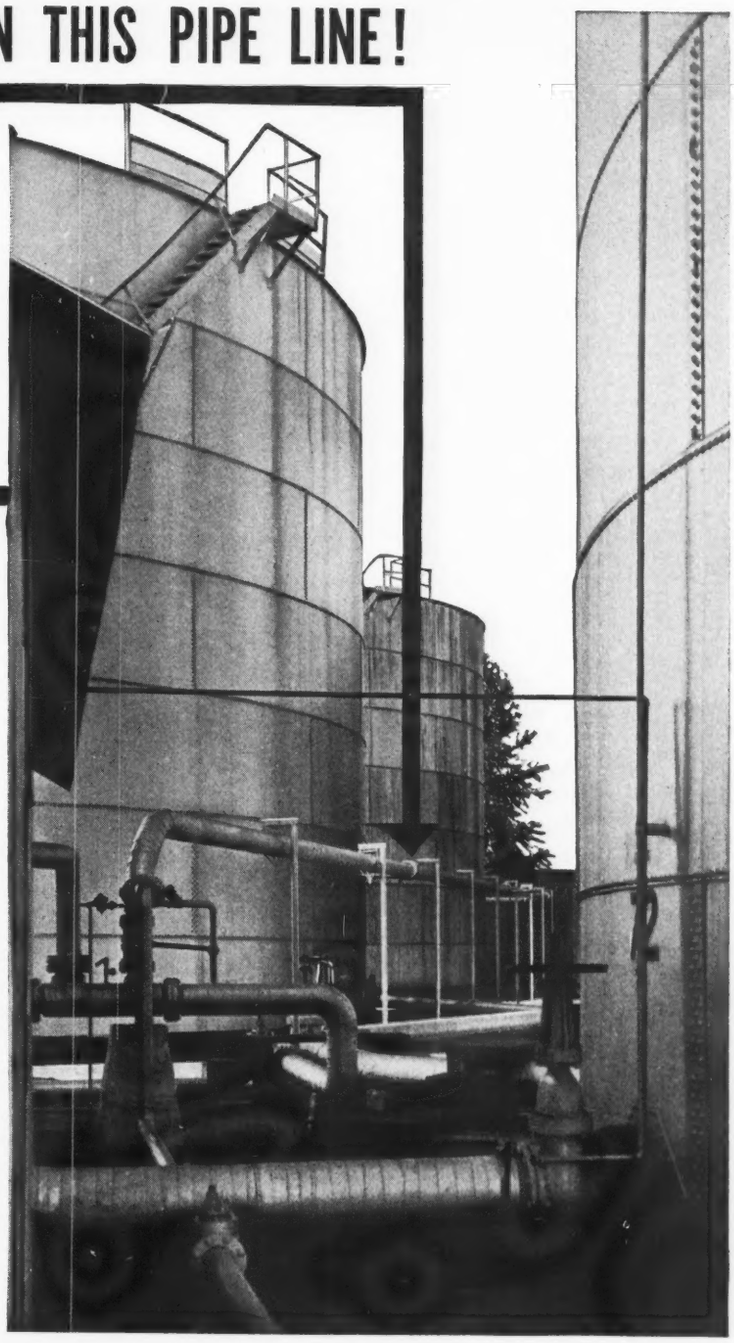
HOMOCORD BELT intended solely for conveyors, and in present stage of development is not applicable to transmission belting or automobile tires. Construction, which employs neither standard weave or standard weave or standard cord design, uses new type of cord specially developed, and new body construction invented particularly for conveyor belt use. Characteristics said to meet adequately every demand of conveyor-belt service in correct proportioning of lengthwise and crosswise strength, flexibility, low inelastic stretch, resistance to fatigue and impact, equal life in body and cover, and other essential qualities. *Manhattan Rubber Mfg Div, Passaic, N. J.*

Forced-Feed Lubricator

NON-REVERSING, single-pipe, centralized forced-feed lubrication system consists of a bank of three or more sections, each of which discharges a known and measured quantity of lubricant alternately through one or two discharge outlets connected to bearings. Capacity or volume of different

NO "FROZEN" ASPHALT IN THIS PIPE LINE!

K&M insulation keeps asphalt hot and free-flowing in this long, outdoor line



HERE is an outdoor pipe line 868 feet long used to carry asphalt in a large western refinery. No matter how hot it is at the start, asphalt would cool down within forty or fifty feet and practically "freeze solid" in an ordinary pipe line. But not in this one! A specially engineered installation prevents it, with the help of Keasbey & Mattison "Featherweight" 85% Magnesia insulation.

Underneath the line carrying the hot asphalt, a small steam line was installed. The pair were then enclosed together and protected against heat loss by a single covering of K&M "Featherweight" 85% Magnesia. The Plant Manager says that a virtually constant temperature is maintained at all times, despite the fact that there are many hours, especially at night, when the asphalt is not flowing at all!

Such an installation as this saves its moderate cost many times over. But only high-efficiency insulation, such as K&M "Featherweight," makes it feasible. The specialized line of K&M asbestos and magnesia insulation materials is saving heat, fuel and dollars for plants in every industry.

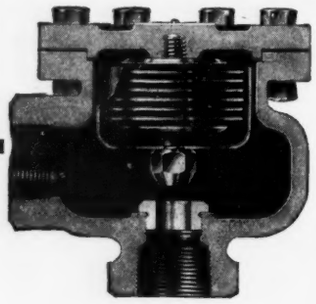
K&M engineers, working with K&M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Write Dept. 11 for full details.

● Showing the hot asphalt-carrying pipe line in a large western refinery. This line is insulated with K&M "Featherweight" 85% Magnesia, which was supplied and installed by Pacific Building Materials Company, Portland, Oregon.

K&M "Featherweight" 85% Magnesia

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA



NICHOLSON

NON-FREEZING, HIGH CAPACITY INDUSTRIAL STEAM TRAPS

These units employ temperature difference between steam and condensate to open and close their valves, a heavy duty thermostatic bellows with brazed end plates being the operating mechanism. They are sturdily constructed and designed for high pressure and severe service. Water and air discharging capacity are extremely high and positive intermittent valve action can be absolutely depended on.

Other advantages include non-freezing, no air binding, dribbling or water-logging.

Available in types and sizes for all services from vacuum up to 300 lbs. with superheat. Ask for bulletin No. 439.

WELDED FLOATS FOR HIGH PRESSURE STEAM AND HYDRAULIC SERVICE

Available in spherical and elliptical shapes in sizes from 2½" to 14" diameter—in stainless steel and in chromium plated steel. Made for all steam pressures up to 1500 lbs. and hydrostatic pressures up to 2500 lbs.

"Nicholson" Welded Floats are *die formed* — not spun or laminated — with welding seam serving as reinforcing ring, and give extraordinary resistance to external pressure. Available also with cadmium, nickel or copper plating. Write for Bulletin No. 339 covering details.

Also: NICHOLSON Control Valves, Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.

HIGH .. in savings

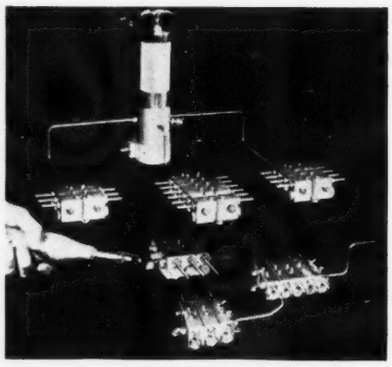
LOW .. in cost

You need never guess about the tabulation of Boiler Feed, Turbine Condensate, Steam, Air or other fluids when you have a Simplex Meter on the job.

Although low in first cost and maintenance and designed for use with orifices, nozzles or venturis — sturdy Simplex Meters provide an accurate summary of fluid flows that pave the way to high savings in plant operation.

There is a Simplex Meter to fit your specific needs. Write for latest descriptive bulletin No. 52.

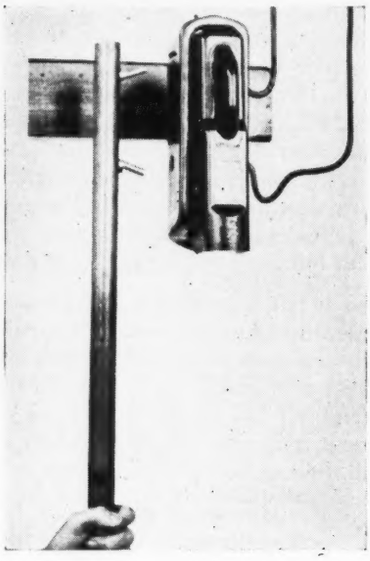
SIMPLEX VALVE & METER CO.
6780 UPLAND ST., PHILADELPHIA, PA



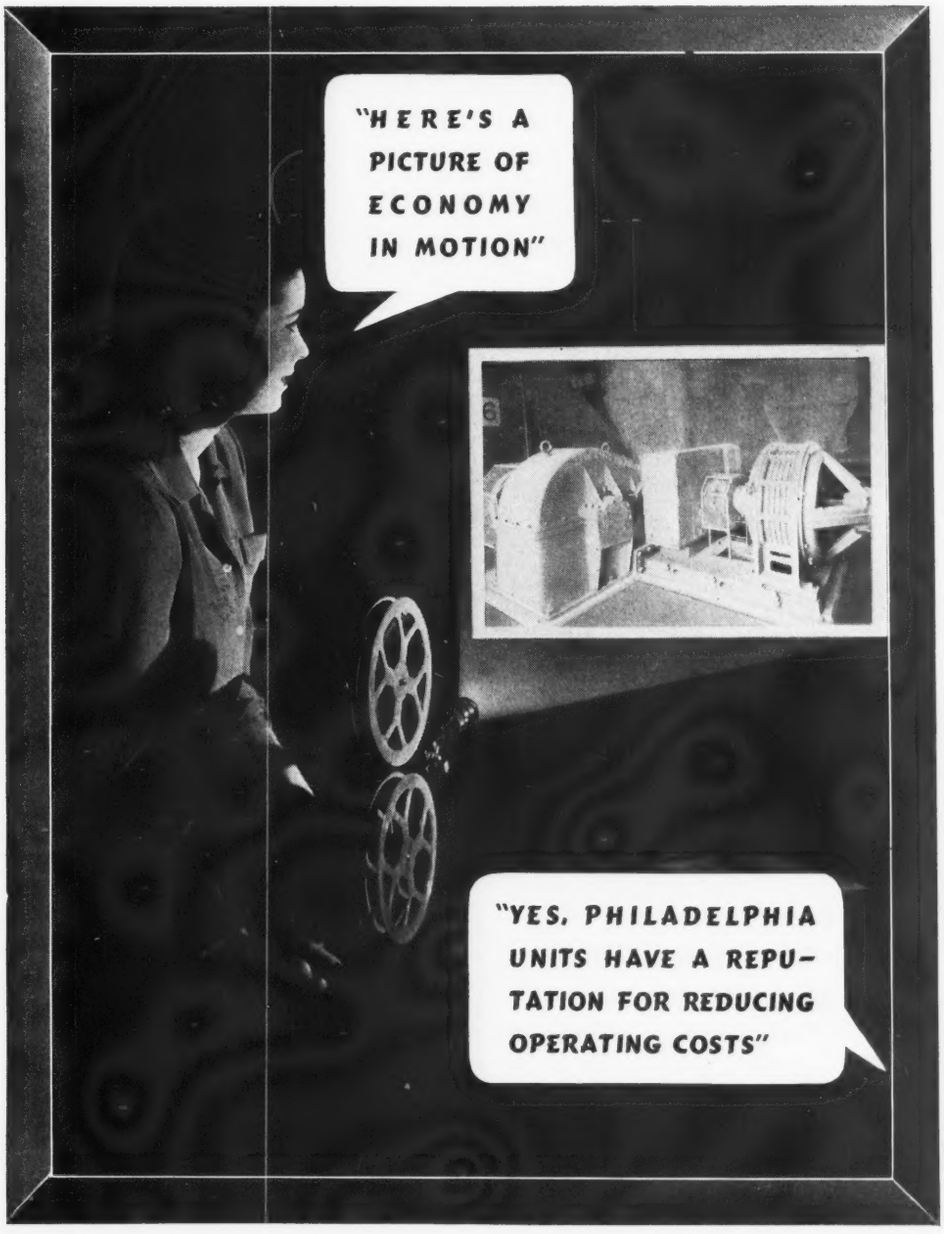
section of same distributor may vary from .005 to .035 cu in. Illustration is view showing a 6-outlet distributor operated manually with a pressure gun; a 6-outlet distributor fed from another distributor; and a 6-outlet, 12-outlet and 18-outlet distributor connected to a Series "MP" variable-feed multi-outlet pump. *Trabon Engrg Corp, Cleveland, Ohio.*

Jumper Stick

JUMPER STICK PERMITS replacement of first fuse link in G-E reclosing cutout without interruption to service. Replaces cable jumper formerly used, which required connections with screw clamps to cutout leads. Unit is Herkolite tube, housing two cast-bronze, nickle-plated contacts separated by stainless-steel compression spring. Contacts



are connected by a flexible shunt of tinned-copper cable, swaged to contacts, giving permanent joint. Both contacts project through slot in tube; upper contact is fixed, while lower can be moved up and down in the slot. Maple pole is fastened to lower contact, sliding within casing and forming jumper stick handle. In use, lower end of casing is held in one hand and handle in other. By pushing handle up within casing, lower contact is moved upward till both contacts can be inserted in openings in cutout housing. When handle is released, contacts are locked firmly against cutout terminals by strong spring pressure. With jumper stick in place, cut-



Philadelphia LIMITORQUE CONTROL operates all types of valves, etc., safely, economically, from convenient stations.
Philadelphia WORM GEAR SPEED REDUCER right angle drives—vertical or horizontal. Wide range of ratios and horsepowers.
Philadelphia HERRINGBONE SPEED REDUCER for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.
Philadelphia MOTOREDUCER The economical self-contained drive. Horizontal or Vertical types—various ratios and horsepowers.
PHILADELPHIA
Philadelphia GEARS All types and sizes of industrial gears. Can be supplied in all materials.

Philadelphia Speed Reducers are widely recognized throughout industry for their high efficiencies . . . their low upkeep . . . their all 'round economy in operation. Year after year they transmit a high degree of input power without trouble, and with little if any attention required. Philadelphia Speed Reducers are available in all types and a wide range of horsepowers and ratios for vertical, horizontal, straight line and right angle drives. Write today . . . outline your problem, and we'll gladly advise the Unit best suited for your needs.

PHILADELPHIA GEAR WORKS

Industrial Gears and Speed Reducers
Erie Ave. and G St.
Philadelphia, Pa.
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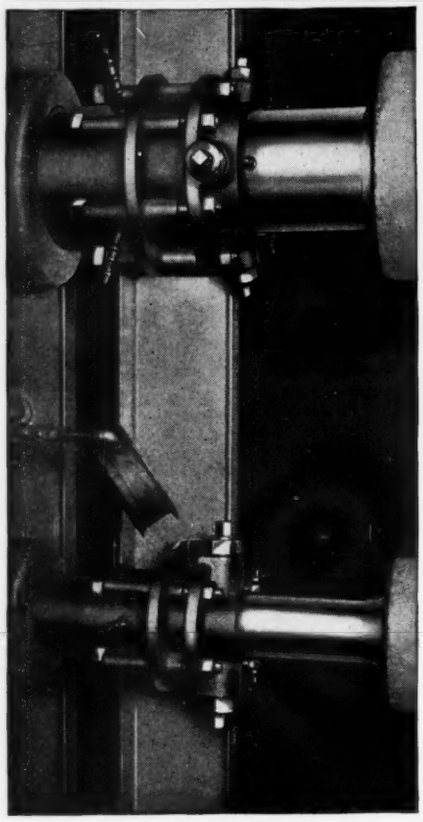
New York • Pittsburgh • Chicago

YARWAY
GUN-PAKT
EXPANSION
JOINTS



Big Automobile Company Uses 67 Yarway Joints

First purchased 3 years ago. Reordered 7 times to present total of 67 Yarway Gun-Pakt Joints, ranging in size from 3 in. to 14 in.

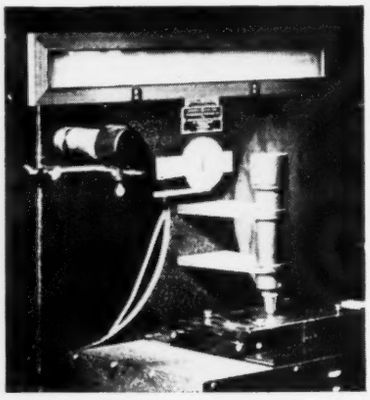
Why don't you select the Expansion Joint that is packed under full steam pressure. A twist of a wrench forces a special semi-plastic packing into the stuffing box by means of integral pressure guns. No need to remove old packing. New packing rejuvenates the old. No need to shut off steam. Write for Catalog EJ-1907.

YARNALL-WARING CO.
100 Mermaid Ave., Phila., Pa.

out door can be opened without interrupting service, as load is bypassed through shunt connecting contacts. After re-fusing and closing door, contact-pressure can be removed and jumper stick removed. *General Electric Co, Schenectady, N. Y.*

Photometer

PHOTOMETER provides rapid and precise method of studying spectrographic plates, according to inventor. Instrument enlarges spectral lines about 20 times and provides a means of determining their intensities by measuring light passing through them to photoelectric cell. From these data, concentration of constituents of al-



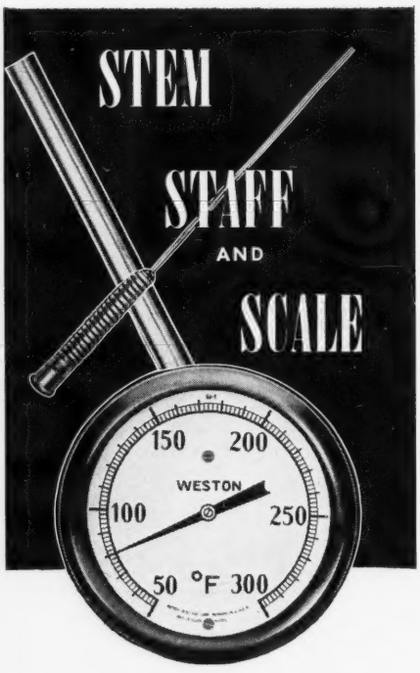
loy is determined. Optical parts remain fixed after final adjustment and require no additional movement for focus. Focussing of spectral lines on screen is accomplished by moving spectrographic plate with respect to condenser and objective. Plate is mounted horizontally and all light control devices and scales are immediately in front of operator. *General Electric Co, Schenectady, N. Y.*

Packing

NON-STAINING PACKING available for apparatus handling liquids that must be kept untainted or uncontaminated. Known as Klero, packing is snow white in color, and has odorless, tasteless, edible and chemically resistant lubricant. It is made of asbestos yarn, and therefore is suitable for high-temperature services. Braid-over-braid construction said to prevent accumulation of solid materials in packing. *Greene, Tweed & Co, 101 Park Ave, New York, N. Y.*

Arc Welder

IDEAL ARC WELDER includes a reactance winding on separate core in addition to transformer. This winding acts as stabilizer, making it easy to strike and hold an arc. As distance between end of welding rod varies, this reactance winding causes voltage to vary proportionately so that arc is always smooth. Fifteen different welding heats provided, between 20 and 175 amp. Penetration may be up to $\frac{1}{4}$ in., or



DOWNRIGHT SIMPLICITY

contributes ruggedness and long-life dependability to

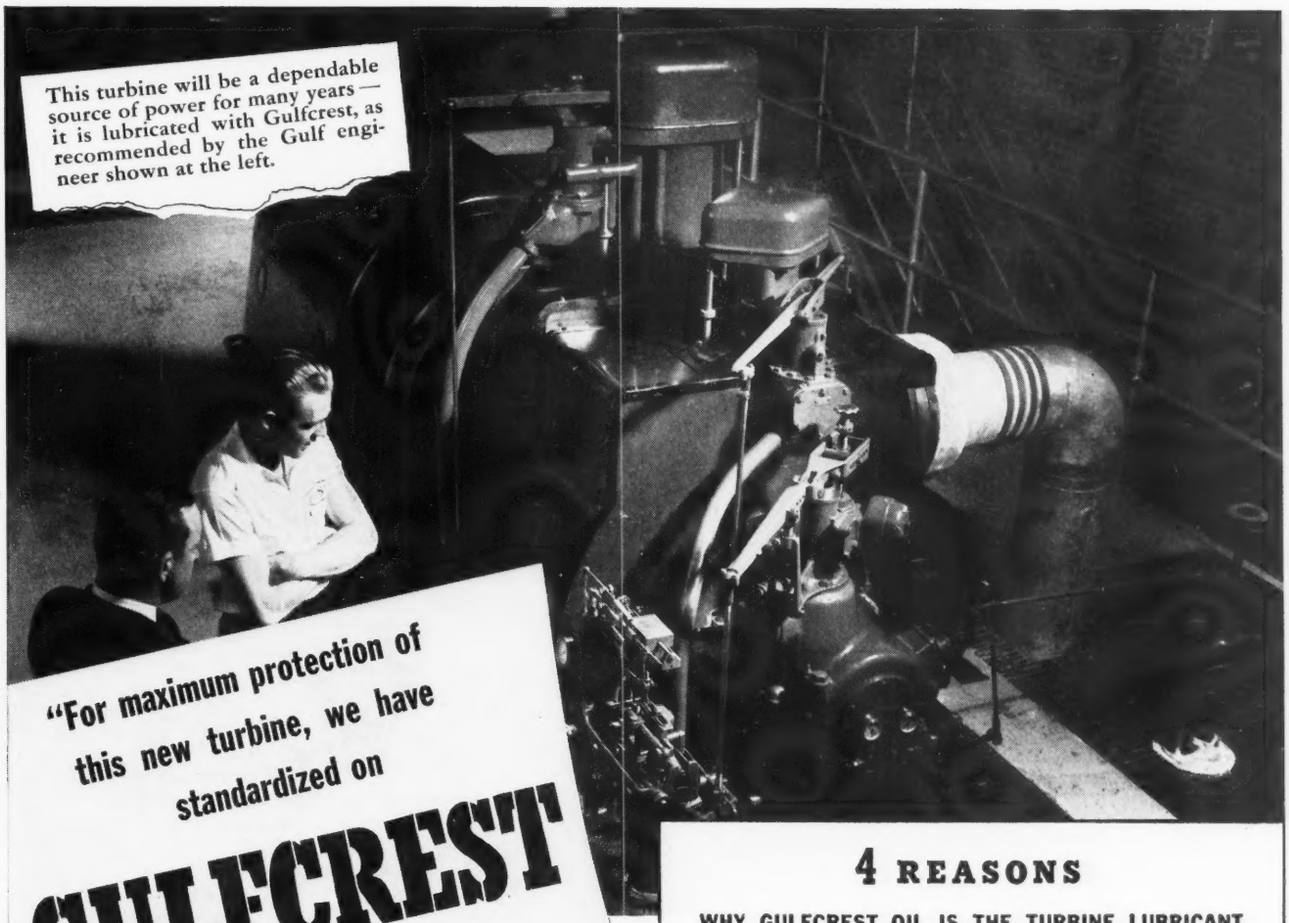
THERMOMETERS

Nothing complex about a WESTON Thermometer... no gears, no liquids or vapors, no capillary. It consists of but a few, simple parts... and those parts made of enduring, corrosion-resisting metal. Thus the WESTON presents fewer opportunities for trouble . . . *and sturdy protection against it.* The result is a thermometer that *maintains* its dependability over longer periods . . . with less breakage... less damage from over-temperatures . . . *one that costs far less, all around.* Bulletin sent on request. Weston Electrical Instrument Corporation, 679 Frelinghuysen Avenue, Newark, New Jersey.

WESTON

ALL-METAL GAUGE TYPE

THERMOMETERS


This turbine will be a dependable source of power for many years — it is lubricated with Gulfcrest, as recommended by the Gulf engineer shown at the left.

"For maximum protection of this new turbine, we have standardized on

GULFCREST OIL,"

says the Chief Electrical Engineer in this paper mill.

4 REASONS

WHY GULFCREST OIL IS THE TURBINE LUBRICANT OF UNMATCHED QUALITY

1. REFINED BY THE ALCHLOR PROCESS. The most thorough and effective method for removing chemically active hydrocarbons as well as the general run of impurities present in all crudes.
2. HIGHEST RESISTANCE TO OXIDATION. Because this famous ALCHLOR Process synthesizes and rearranges the molecular structure of certain hydrocarbons, resulting in a finished product of greater stability, GULFCREST OIL stands alone in its high resistance to oxidation.
3. HIGHEST RESISTANCE TO ACIDITY AND SLUDGE. Because of the elimination of oxidation catalysts in addition to the unparalleled refining power of the Alchlor Process, these oils form less gum and deposits, less emulsion and sludge, when mixed with water over a period of several years continuous operation, than any other turbine oil of which we have record.

4. HIGHEST KILOWATT-HOUR PERFORMANCE. Because Alchlor not only makes possible an oil more thoroughly refined and homogeneous, but also creates anti-oxidants, these oils have great resistance to deteriorating influences and are longer lived. Less makeup oil is required.

"Right from the start we insured against trouble due to Turbine Oil Deterioration."

"This turbine must be a dependable source of power for a good many years to come," says the chief electrical engineer in this plant. "That's why we standardized on Gulfcrest Oil to lubricate it right from the start. This oil shows remarkable ability to retain its original characteristics without deterioration."

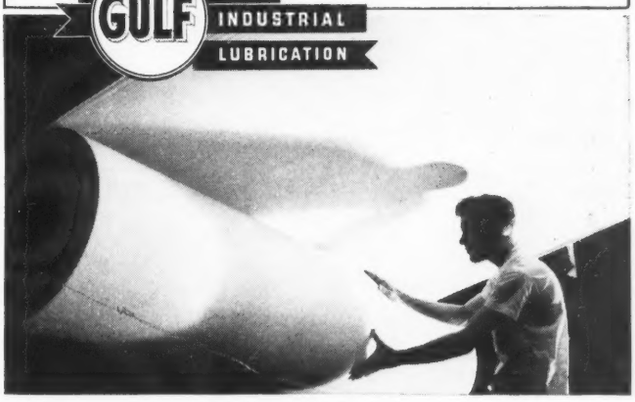
Turbine operators from Maine to New Mexico who have standardized on Gulfcrest Oil are finding that it is the most stable turbine lubricant they have ever used. Here is the reason: *Gulfcrest Oil is especially refined and purified by the Alchlor Process,* the most efficient method yet developed for removing undesirable hydrocarbons and other impurities which cause oxidation and sludge formation.

There is a *real quality story* behind Gulfcrest Oil. Ask the Gulf engineer in your vicinity to give you complete details.

GULF OIL CORPORATION · GULF REFINING COMPANY

GULF BUILDING, PITTSBURGH, PA.

GULF INDUSTRIAL LUBRICATION



DAVIS *Swing Check* VALVES

for

MAXIMUM SAFETY

•

FULL FLOW

•

SENSITIVE ACTION

•

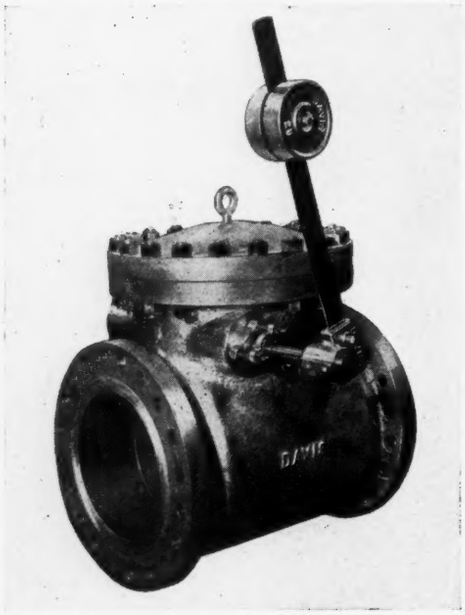
ANY PRESSURE

•

ALL SIZES

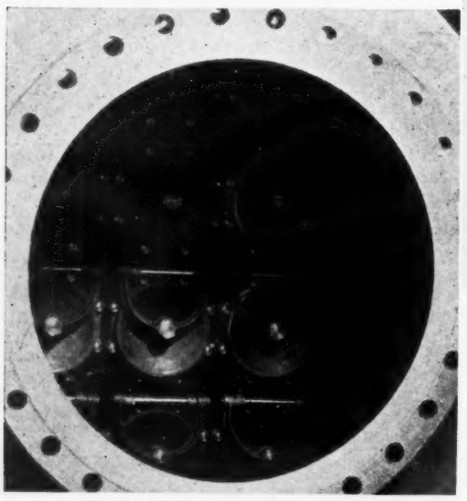
•

ALL TYPES



Above—Davis No. 134 Balanced Swing Check Valve for simple, positive check valve service.

IF it's Check Valves, Davis is your answer! The Davis Line provides the *right valve* for the job—And Davis quality keeps it on the line for years of low-cost service. Types for every service requirement. Write today for Bulletin 101-A, giving full details and prices. DAVIS REGULATOR CO., 2540 S. Washtenaw Ave., Chicago, Illinois.



Above—Davis No. 130 Turbine Bleeder Non-Return Valve for certain safety control. Equipped with oil cylinder for automatic emergency closing.

Left—Davis No. 132 Multiple Disc Non-Return Valve for trouble-free low pressure service.

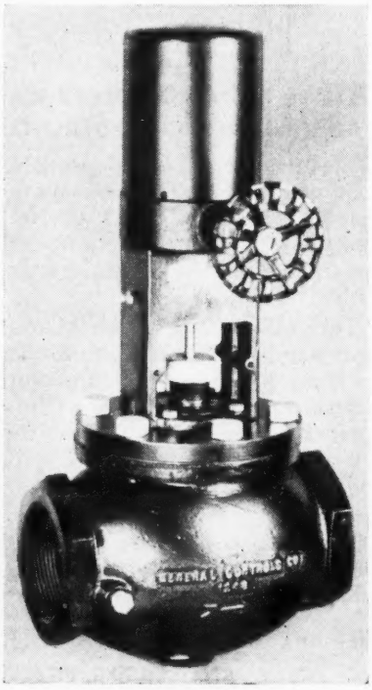
Before you buy—Check with Davis!

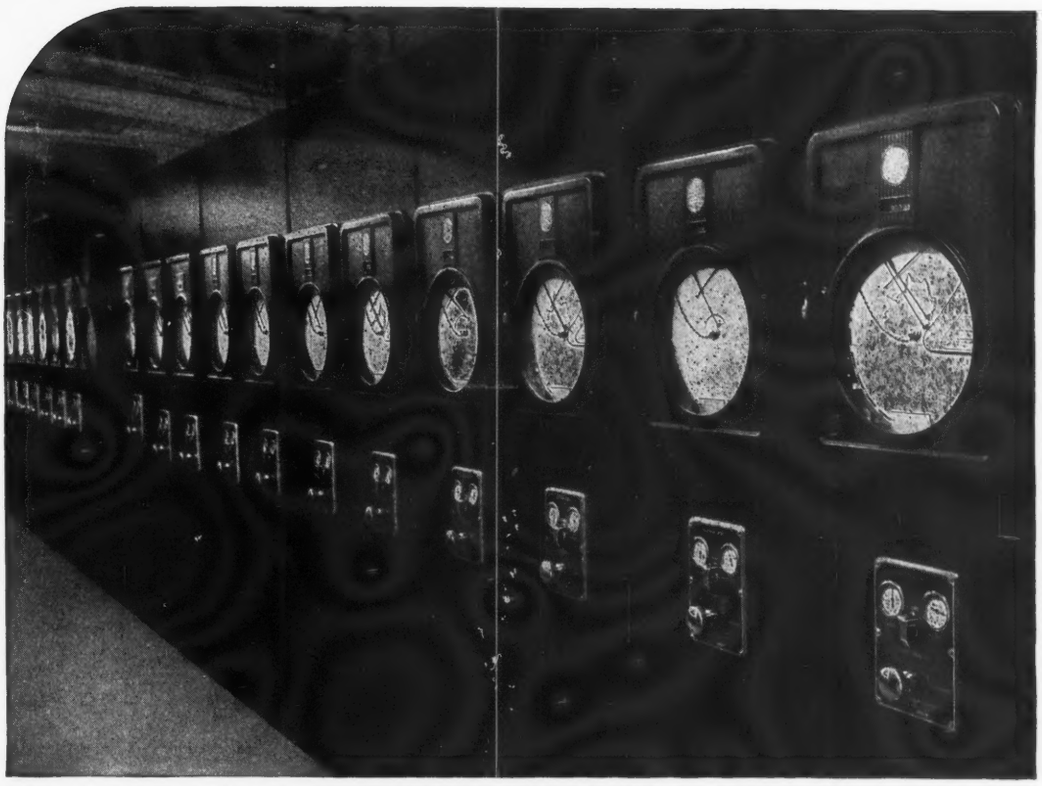
DAVIS REGULATOR COMPANY

more, if desired by operator. Standard welder is for 230 volt, 60-cycle operation. Primary current is 1.75 amps, no load, 52 amps, full load. Accessories available include ground lead, electrode lead, electrode holder, welding rod, primary cord and plug. *Ideal Commutator Dresser Co, 1025 Park Ave, Sycamore, Ill.*

Manual Reset Valve

SERIES MR-1-2 OFFERED for positive control of water, air, gas, steam and oil in many industrial applications. Control is operated by external magnetic operator, not subject to dirty, viscous or high-temperature fluids the valve may be handling. On





This installation of Bailey Meter Control on gas fired boilers at The Colorado Fuel and Iron Co. paid for itself in Six Months.

COMBUSTION CONTROL "PAYS OUT" IN 6 MONTHS

COMPLETE CONTROL AT MINNEQUA WORKS RAISES EVAPORATION RATIO FROM .486 TO .593 POUNDS PER CUBIC FOOT OF GAS

● Late in 1938 The Colorado Fuel and Iron Co. installed Bailey Meter Control on one boiler. Satisfactory results obtained from this first test installation were responsible for the installation of Bailey Meter Control on four additional boilers during the early part of 1939.

At the end of 1939, a comparison of evaporation ratios obtained with and without automatic control indicated that Bailey Meter Control had increased this figure from .486 to .593 pounds per cubic foot of natural gas. This increase represents a rate of fuel saving sufficient to pay off the entire cost of the Bailey Meter Control in six months.

Because of these results, Bailey Meter Control was ordered for ten more boilers.

The installation of COMPLETE Combustion Control which: (1) Automatically maintains desired steam pressure; (2) Automatically maintains most economical fuel—air ratio; (3) Automatically maintains the division of load between boilers; (4) Automatically maintains desired furnace draft; is one of the few "high return" investments open to your company today. Send for your copy of Bulletin No. 102-C describing Bailey Meter Control.

BAILEY METER COMPANY
1036 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada A60-1A

BAILEY METERS

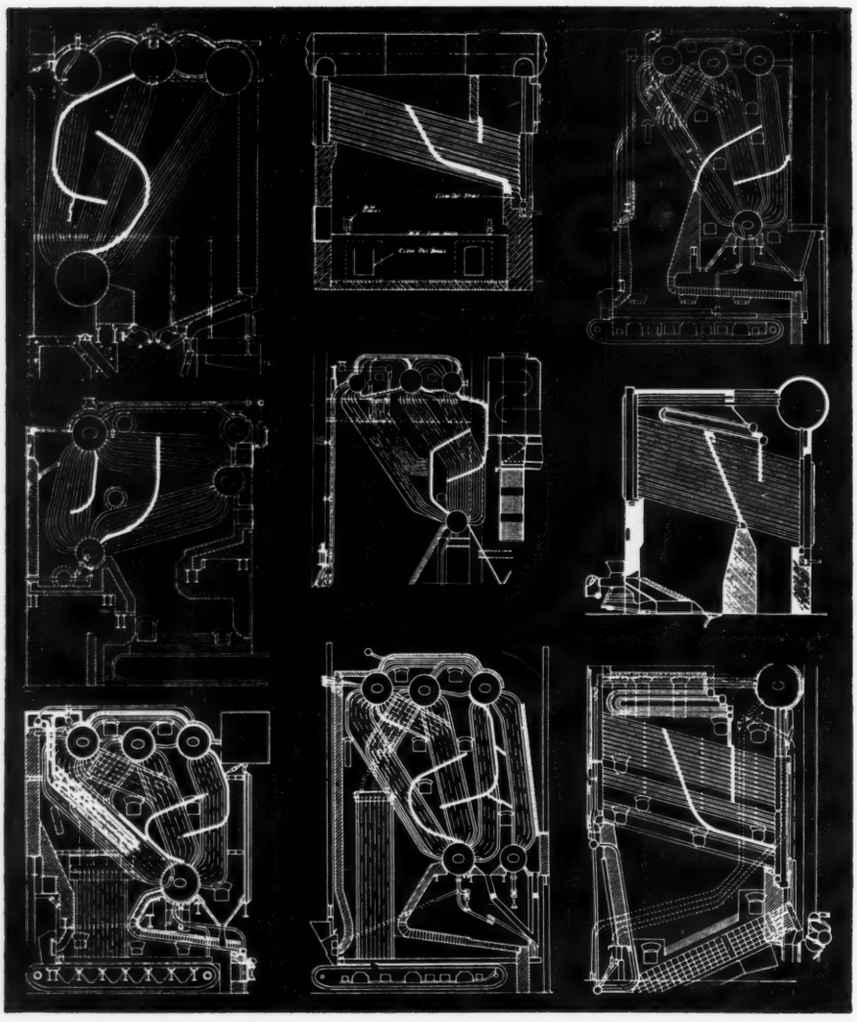
BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

Enco Streamline Baffles

CAN INCREASE THE CAPACITY AND EFFICIENCY IN EXISTING OR NEW BOILERS



Installation of ENCO Baffle Walls in all types of water tube boilers has resulted in immediate improvement in performance, operation and maintenance.

Better heat distribution, maximum heat transfer to boiler and superheater surfaces, lower draft loss, lower flue gas temperatures and higher capacity are assured through ENCO design and construction. In addition, the smoothly curved surfaces of ENCO streamlined baffles tend to prevent fly ash and cinder accumulation, saving time and steam by making it easier for soot blowers to do a more thorough and efficient job of keeping heating surfaces clean.

ENCO Baffles, constructed gas tight with Enco Plastic, Tile and Reinforcement provide for expansion and assure extra strength. They may be built in desired locations assuring minimum disturbance when tube renewals are required.

Flexible design, the careful selection of materials and their installation by experienced mechanics result in a construction which can be depended on for long service under severe operating conditions.

TAKE ADVANTAGE OF ENCO SERVICE TO IMPROVE YOUR BOILERS

Send blue prints and operating data and ask ENCO engineers to submit suggestions. No obligation, of course. Ask for the new Enco bulletin BW 40—sent FREE on request and containing detailed engineering information on modern ENCO Baffle Walls for all types of water tube boilers. Write for your copy TODAY.

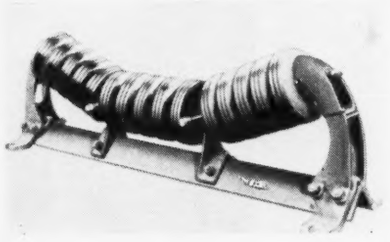
THE ENGINEER COMPANY

75 West St., New York, N. Y.

current failure valve closes and cannot be opened till current is available, and then only by manually resetting it. Operator is equipped with double release mechanism to minimize energy requirements for valve operation, which are low. *General Controls Co, 801 Allen Ave, Glendale Calif.*

Pneumatic Carrier

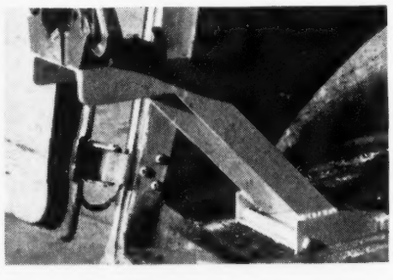
PNEUMATIC ROLLER, for carriers on belt conveyors, is used wherever shocks of impact are excessive. Specially designed for under loading spouts and in belt feeders where impact of heavy bulk loads subject both conveyor belt and carrier to abnormal strains and wear. To cushion im-



pact of materials, rollers in these carrier are made up of a series of pneumatic rubber units, 6-in. in diameter, similar to miniature automobile tires. Rollers in carriers mounted on steel hub in which bearings and shaft are housed. Roller units have thick, wear-resisting treads, and are inflated and permanently sealed to prevent loss of air. *Stephens-Adamson Mfg Co, Aurora, Ill.*

Vise Bracket

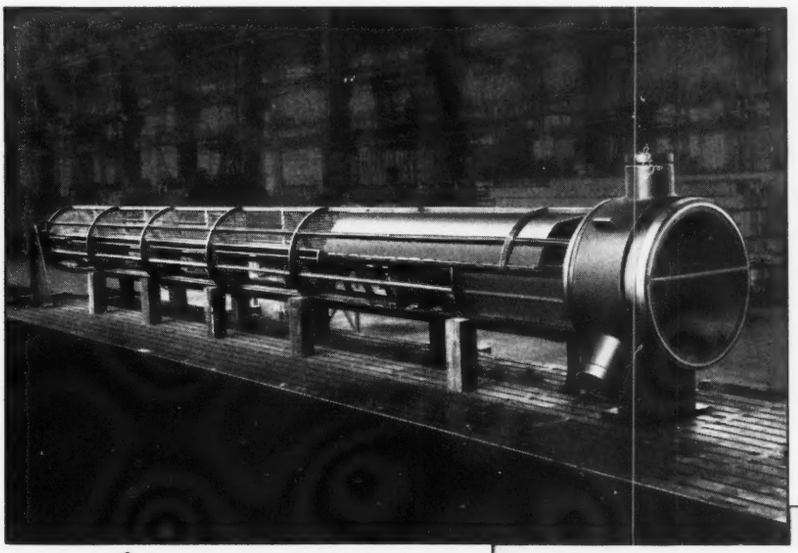
ALL-STEEL FOLDING BRACKET, when in working position, provides rigid support for threading, filing, sawing and other heavy work. Can be attached to floor of truck, as shown, and can be used for mounting either a pipe or machinist's vise. *Jiffyon Mfg Co, 1752 South Taylor Rd, Cleveland Heights, Ohio.*



Boiler-Room Smoke Alarm

WORNER "FOTOELECTRIC" SMOKE ALARM consists of two mounting flanges, one for each side of breeching, and control cabinet, to be located in most conveniently accessible place. Mounting flanges are placed diametrically opposite each other, one containing light source and opposite one holding

ALCO
FEED WATER HEATERS
Insure...



1 Noiseless Trouble-free Operation.

2 Rugged tube bundle construction.

3 Even steam distribution throughout shell space.

4 Freedom from gasket troubles.

5 All parts readily accessible.

6 Minimum number of parts to handle when dismantling for inspection.

features

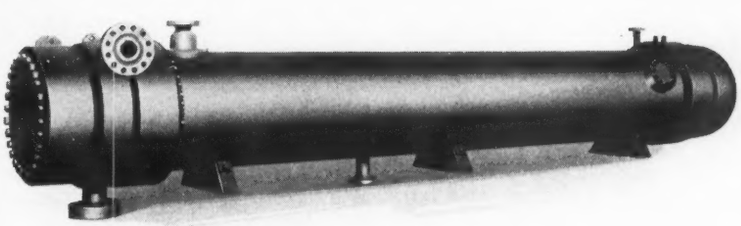
1 Heavy Tube Support Plates with drilled and reamed tube holes having chamfered edges.

2 Sufficient heavy tie rods for holding tube supports rigid.

3 Impact baffles under each shell inlet nozzle.

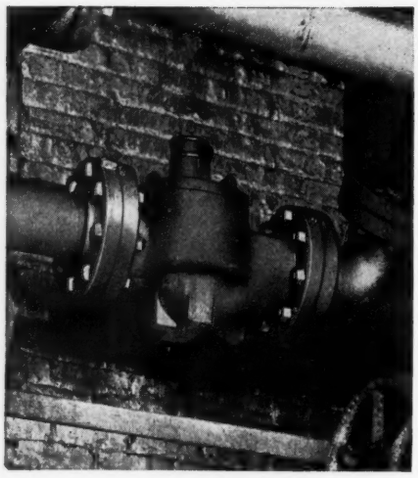
4 Tongue and groove gasket joints throughout.

5 Clamp rings with compression bolting for attaching heads and covers.



Write for Bulletin-1024

AMERICAN LOCOMOTIVE COMPANY
ALCO PRODUCTS DIVISION
30 CHURCH ST., NEW YORK, N. Y. **DUNKIRK, N. Y.**



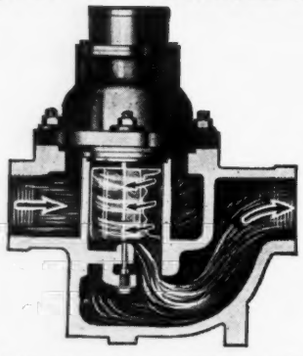
IT'S HOT
IT'S DIRTY
IT'S ABRASIVE
IT'S CORROSIVE

IT'S a tough job, but Boiler Blowdown can be accurately and reliably measured with

HENSZEY
FEED WATER
METERS

The Henszey meter has successfully measured boiler blowdown, feed water, condensate, free running chemicals and other "hard-to-measure" liquids where other meters have failed one after another in a short time. Check your meter equipment today, and send for complete information about Henszey Meters for your job.

HENSZEY COMPANY
Dept. D6 Watertown, Wis.



Water enters the measuring chamber tangentially, spinning in the chamber as it passes through, forming a vortex. Each gallon that passes through this chamber makes the same number of revolutions of the water. A vane is placed in the rotating water to impart this rotation to the register. No close clearance—less wear—continued accuracy.

HENSZEY

photocell housing. When beam from light source to photo cell is interrupted by any predetermined density of smoke, apparatus registers this density of smoke on meter, located on door of control panel. System can be supplied with auxiliary relay contact, which can be made to control any apparatus, such as valves or dampers, when smoke reaches predetermined density. *Worner Products Corp, 1019 W Lake St, Chicago, Ill.*

Welding Ring

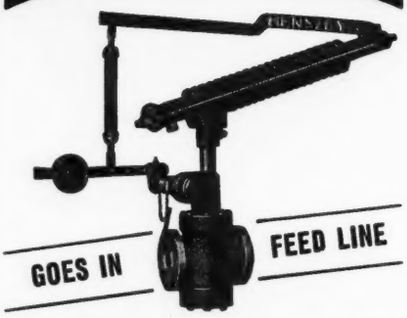
TUBE-TURN WELDING RING will align and hold together almost any combination of fittings and pipe, according to maker. No clamps, guides or fixtures needed for supporting fittings and pipe for tack welding. Ridge on ring spaces welding ends exactly and automatically. In acetylene welding, larger rod and tip can be used for faster work. Since there is no danger of weld-

metal getting inside joint, less manipulation of rod and torch are required. Either forehand or backhand method may be used. In electric welding, larger electrodes and higher amperage can be used, speeding up job. One entire pass is eliminated and rings enable less-experienced operators to arc-weld with greater confidence and ease, by reducing difficult manipulation and danger of burning through. *Tube Turns, Inc, 224 E Broadway, Louisville, Ky.*

Centrifugal Pump

LINE OF WESTCO CENTRIFUGAL PUMPS marks company's entry into centrifugal pump field. Streamlined pumps are available as flexible coupling drive models in sizes 1¼ to 6 in., and Uni-Bilt Models, illustrated, in sizes 1¼ to 4 in., inclusive. Heavy close-grained cast-iron torpedo-type frame absorbs operating strain and guards against misalignment, while suction cover is rib-

HENSZEY
BOILER FEED
REGULATORS



The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept D6—Watertown, Wis.

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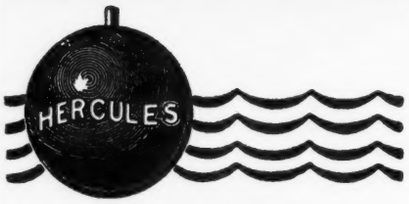
Seamless Copper
FLOATS



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Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

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INTERNAL COMBUSTION ENGINE NEWS

★ ★ ★ NEWS FLASHES FOR POWER USERS ★ ★ ★ 962-7

Prepared by Ingersoll-Rand Co.
Main Office: 11 Broadway, New York City
Branch Offices & Warehouses:
The World Over

Former Rivals Cooperate

It may surprise many readers to learn that the Diesel engine is not necessarily the enemy of steam power. Two news items on this page describe plants in widely varying fields, in which a Diesel engine is working in close harmony with a steam power plant, thereby effecting higher economies than would be possible if *all* of the power were produced by either Diesels or steam.

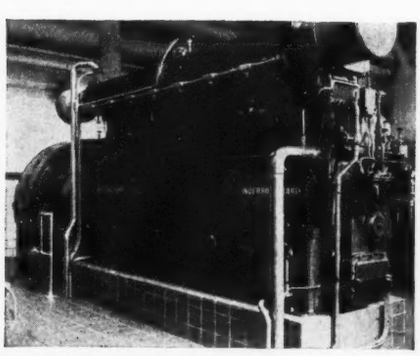
At Sea

In the Maritime Commission installation the main power plant was preferably steam, because of the large amount of power involved. The Diesel engine was added to handle certain peak loads conveniently. The moderate expenditure for the Type "S" Diesel avoided a much larger investment increase for additional boiler capacity, condensers, boiler feeds pumps, main circulators, etc. With the Diesel engine it is also possible to remove both boilers from service for inspection in port, without interrupting the ship's service.

On Land

In the Seagram installation a large quantity of exhaust steam could be used for process work, and a non-condensing steam plant produced power and supplied this steam at the same time. When more power was required, however, no additional process steam was necessary. Hence the installation of a Diesel-generator set was more economical than a new condensing steam plant, both in first cost and in operating cost.

There are many similar places in industry where a combined plant could be profitably applied, and it is a tribute to the progressiveness of Diesel and steam engineers that, instead of fighting each other, they are cooperating in a way which was not deemed possible in the past.



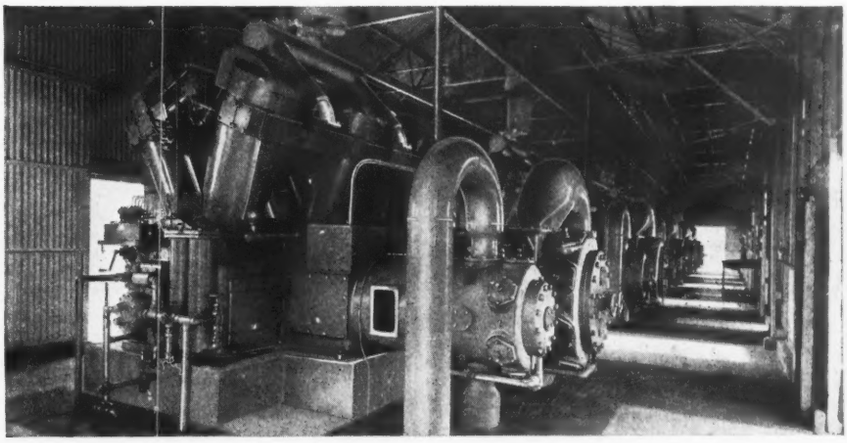
Eight-cylinder Type "S" Diesel generating set in the Seagram distillery at Lawrenceburg, Ind.

Diesel Auxiliary Engine Power in Maritime Commission Steamships

Independent Power Supply Permits Complete Shutdown of Steam Plant Without Interrupting Service

NEWPORT NEWS, VA.—350-KW Ingersoll-Rand Type "S" Diesel engine generator sets have been installed on the SANTA ANA and the SANTA TERESA, built under the Maritime Commission at the Newport News Shipbuilding & Dry Dock Co. Steam is used on these vessels for main propulsion and for normal ship service. The Diesel generator set provides peak power for pulling down the temperatures in refrigerating space at the beginning of the voyage, and to take care of ship's service in port, when the boilers are shut down for inspection, cleaning or repairing. A ship duplicating this unusual power plant, is now in the process of construction at the Federal Shipbuilding and Drydock Co., Kearney, N. J.

Gas-Engine-Driven Compressors in Oil-Field Service



Five direct-connected, gas-engine compressor units, totalling 2400 hp. are compressing natural gas in the new gasoline extraction plant of the Shell Oil Company, in Magnolia, Arkansas. Two similar units, each of 650 hp., have just been installed in a modern natural gas recycling plant in Texas. There the gas pressure is raised from approximately 1400 lb. to 2150 lb., the discharged gas being returned to the ground. Many such plants have gone into operation in the mid-continent field during the past several years.

Diesel-Engine Compressors in Reed Co. Plants

ROCHESTER, N. Y.—In February, 1928, the F. E. Reed Glass Company installed two Ingersoll-Rand 100-hp. Type POC-1 direct-connected, oil-engine-driven compressors in the Mt. Read Blvd. plant in Rochester. Later another unit was placed in the Maple Street plant, and for many years these three machines produced air for manufacturing operations. Recently, when additional capacity was required, the company installed in each plant an Ingersoll-Rand Type 4-XVO-1 oil engine compressor unit—the type which has superseded the original POC units.

Diesel Engine Balances Heat Cycle at Seagram & Sons

New Engine Improves Control of many Distillery Processes

LAWRENCEBURG, IND.—Unique advantages are credited to the installation of an Ingersoll-Rand Type "S" Diesel-generator set in the Lawrenceburg, Ind. distillery of Joseph E. Seagram & Sons, Inc. Not only has the unit saved money in supplementing an existing non-condensing steam plant but the quality of the plant's chief product, whiskey, has been improved! Previous to two years ago, all power was developed by steam, and blending, bottling work and other operations requiring power were governed by the need for exhaust steam used in mashing and distillation. The former operations can now be carried on independently of the latter—and hence can be performed at the exact time most desirable to improve the quality of the product.

Panama Canal Buys Diesel-Engine Compressors

A drill boat recently purchased by the Panama Canal Commission, will be equipped with four Ingersoll-Rand direct-connected oil-engine driven compressor units of the XVO type. Each unit compresses 1250 cfm of air to 100 lb. discharge pressure. Because of the "V" construction, this type of unit is particularly adapted for installation on a drill boat; unbalanced rotative forces are reduced to a minimum. The compact design is very saving of space and the direct-connected feature results in a low cost of compressed air.

not 1 out of 2
not 3 out of 4
not 4 out of 5
but
more than 9 out of 10

FREE WORKING SAMPLE

90%+ is mighty close to being unanimous. And that's the percentage of engineers who have become permanent users of PALMETTO Packing after testing a sample in a stuffing box.

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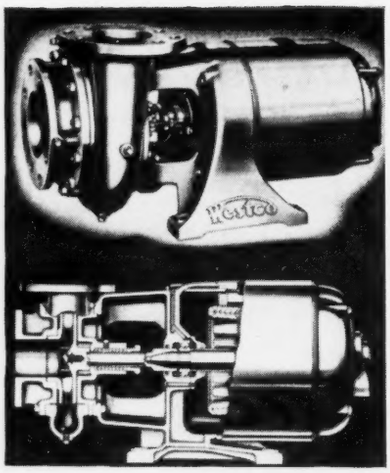
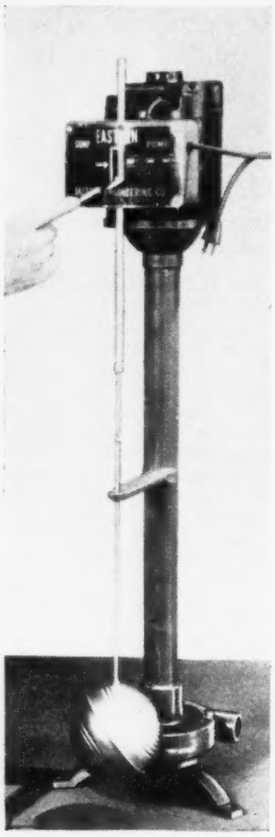
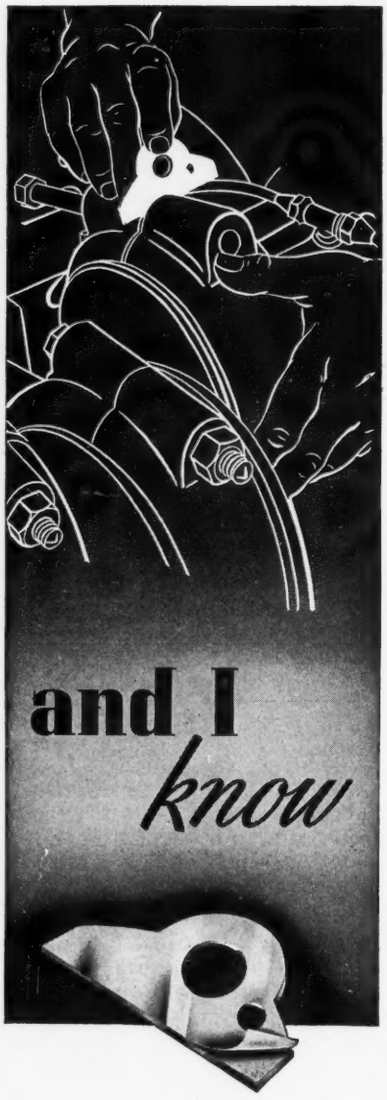


reinforced to withstand distortion. Enclosed or semi-open impellers are hydraulically and mechanically balanced. Enclosed style recommended for handling clear liquids has triple-faced wearing surface, can be adjusted to compensate for wear. Semi-open, non-clog impellers should be used for liquids containing foreign material in suspension. Special metal pumps for handling corrosive or abrasive liquids can be furnished to meet specific pumping requirements. Discharge can be installed in four positions without reducing accessibility of stuffing box. *Micro-Westco, Inc, Bettendorf, Iowa.*

Sump Pump

EASTERN PUMP can be used for automatic drainage of seepage, overflow, etc, from cellars, elevator or boiler pits, etc. Rated





it's .002"

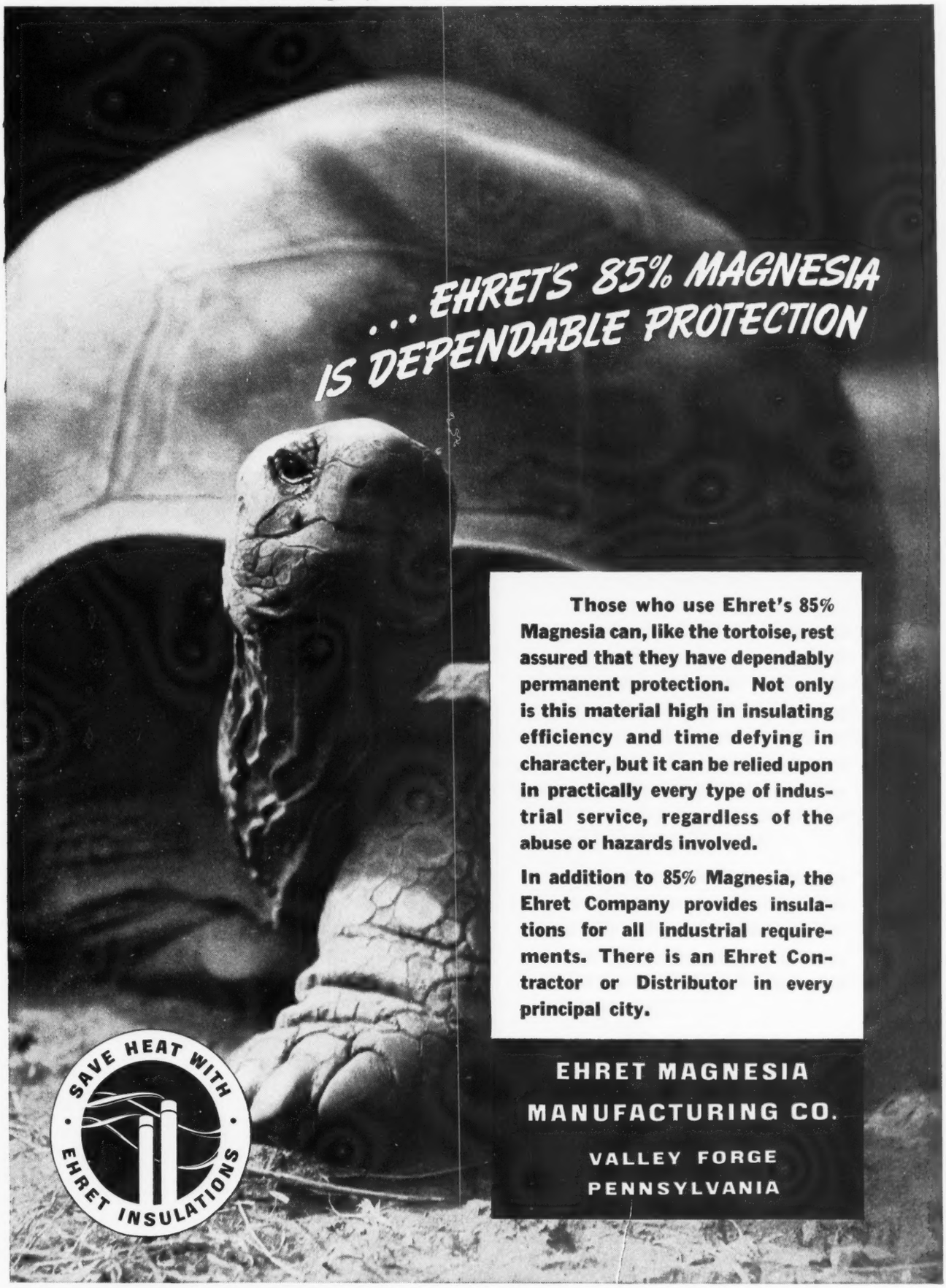
The assembly mechanic knows his LAMINUM shims. Each .002 or .003 inch brass lamination he *peels*, leaves a smooth, hard surface; a uniform thickness. Quick precision adjustment—at the job! Machine manufacturers *profit* by LAMINUM cost-cutting of assembly or repair. *Aircraft* too! ● *We cut shims to order. Stock shim materials obtainable from mill supply dealers.*

Laminated Shim Co., Inc.
61 Union St., Glenbrook, Conn.

Write for file-folder of shim application photos—with Laminum sample.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT
A-1146

Insulation Facts · Number 3.



Those who use Ehret's 85% Magnesia can, like the tortoise, rest assured that they have dependably permanent protection. Not only is this material high in insulating efficiency and time defying in character, but it can be relied upon in practically every type of industrial service, regardless of the abuse or hazards involved.

In addition to 85% Magnesia, the Ehret Company provides insulations for all industrial requirements. There is an Ehret Contractor or Distributor in every principal city.

EHRET MAGNESIA MANUFACTURING CO.

VALLEY FORGE
PENNSYLVANIA

MAKERS OF INDUSTRIAL INSULATIONS FOR MORE THAN 40 YEARS

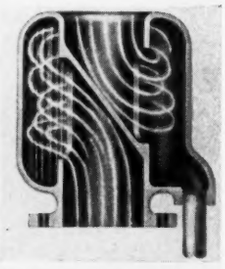
In more than
12,000 Plants
COCHRANE
MULTIPORT
RELIEF VALVE

Cochrane Multiport Back Pressure Relief Valve with front and back plates removed.

Successful operation of the Cochrane Multiport Valve in more than 12,000 plants is a sure guarantee of its continuously reliable operation. This continuous operation is insured by the multiport principle — a number of small discs instead of one large disc, eliminating the sticking, jamming and freezing common to single-disc valves in the control of atmospheric relief, back pressure, etc.

Call your Cochrane representative or write for further details.

COCHRANE Exhaust Head



Designed to separate condensate and oil from steam discharged to atmosphere and thereby prevent raining of water and oily condensate on the roof, Cochrane Exhaust Heads incorporate a highly efficient free-flowing baffle type construction and an exceptionally large port area which minimizes back pressure. Write for further details.

COCHRANE CORPORATION
3106 N. 17th Street, Philadelphia, Pa.

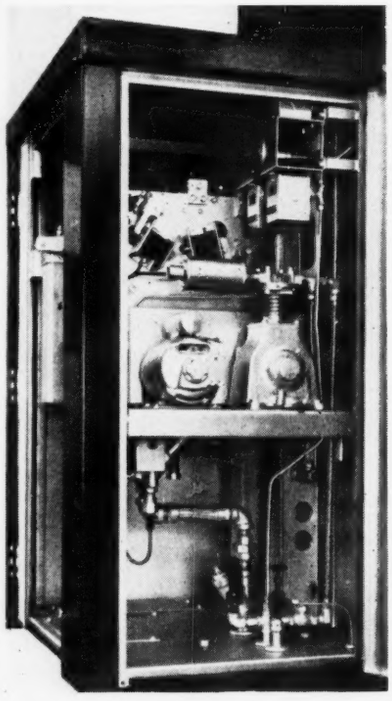
COCHRANE

Cochrane Corp., 3106 N. 17th St., Phila., Pa.
Please send me complete information on Cochrane Multiport Relief Valve and Cochrane Exhaust Head.
Name_____
Firm_____
Address_____
City_____ State_____

at 220 gph at 2 ft head, and 1800 gph at 10 ft head. Float adjustment can be made by thumb screw, and completely encased toggle switch and copper float assures positive automatic action. Operated by ¼-hp, 1725-rpm, induction-type heavy-duty continuous operation, semi-enclosed Westinghouse motor. *Eastern Engrg Co, 45 Fox St, New Haven, Conn.*

Operating Mechanisms

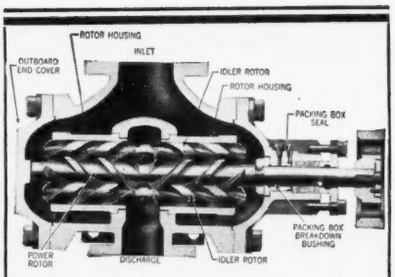
PNEUMATIC OPERATING MECHANISMS now available for G-E outdoor oil-blast circuit breakers. These require low operating current, according to manufacturer, and design provides fast operation without ab-



normal stresses on breaker. Standard compressor unit is driven by small motor, either ac or dc operated. Pressure switches assure adequate operating pressures and air supply system has capacity for sufficient breaker operations to take care of any normal operating condition. *General Electric Co, Schenectady, N. Y.*

AC Generator

ADDITION OF NEW 110/220-volt, 10-kva, single-phase ac generator to line announced. Generator is 4-pole type, 1800 rpm. Voltage and regulation between no load and full load is about 8%, with 3% speed change. Overload capacity 25% with negligible temperature rise. Alternator field coils are excited from small generator mounted on outer endbell. Armature is carried on two cartridge-type double-sealed ball bearings, while shaft and bearing seats are precision-ground. All brushes easily available for examination and replacement. In places where extreme compactness is desired, alternator can be furnished with small belt-driven ex-



***Only* 3 MOVING PARTS**

The DE LAVAL-IMO Pump consists of a casing enclosing a power rotor and two idler rotors. There are no valves, no timing gears, no separate bearings, and only one stuffing box, which is under suction pressure. All parts are in perfect rotary and hydraulic balance and the delivery is continuous and uniform, as from a piston moving steadily in one direction. There is no vibration or pulsation. IMO pumps run at motor or turbine speeds and handle all oils in all quantities against all pressures.

Ask for Catalog I-79

IMO
I MOVE OIL

IMO PUMP DIVISION
De Laval Steam Turbine Co.
Trenton, New Jersey

Lonergan

SPECIALTIES
GAUGES
Valves

Model "HDF"
HIGH PRESSURE HYDRAULIC OR OIL RELIEF VALVE

It's made with heavy drop forged steel body, cast steel bonnet and cap. Seats are either monel or stainless steel suitable for high pressure oil or gas service, or where bronze would be attacked. Can be furnished with exposed spring.

WRITE FOR CATALOG

J. E. LONERGAN CO.
Second & Race Sts., Phila., Pa.
300 Specialties for Power Plants-Since 1872

A TOUGH JOB ...MADE EASY

When you come to the short radius bends, your appreciation of Youngstown Buckeye Conduit's ductility will be immeasurably increased. You will find, too, that this ductility is uniform and will tend to eliminate lost motion in installation.

Ductility is but one of the many desirable qualities of Buckeye Conduit. This high quality is due to the careful watchfulness of the men who make it, the skill which comes only with long years of experience, and the pride Youngstown workmen take in producing an electrical conduit you can use with satisfaction and profit.

Ask your distributor for Youngstown Conduit - Pipe and Tubular Products - Sheets - Plates - Tin Plate - Bars - Rods - Wire - Nails - Tie Plates and Spikes.

26-18D

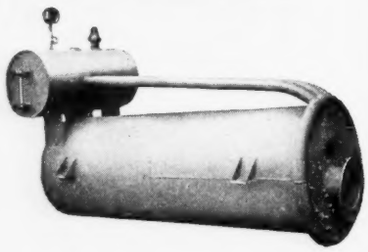
BUCKEYE TRADE MARK YOUNGSTOWN CONDUIT

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steels

General Offices - YOUNGSTOWN, OHIO

MAXIM
WASTE HEAT BOILERS

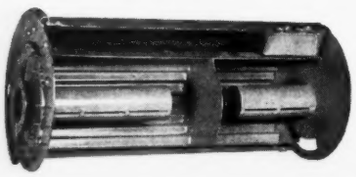


an efficient method of using exhaust heat

With the new Maxim Waste Heat Unit you can conserve exhaust heat (usually wasted) to produce hot water or steam.

This latest Maxim development combines efficient silencing (and spark arresting when necessary) with the conservation of waste heat.

It operates without in any way reducing the efficiency of the equipment on which it is installed.



SEND THIS COUPON FOR DETAILS

THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.

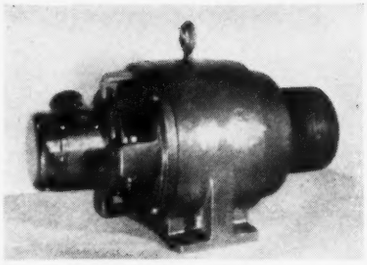
Please send details on your waste heat unit ☐for hot water ☐for steam.

Name.....

Company.....

Address.....

City..... State.....



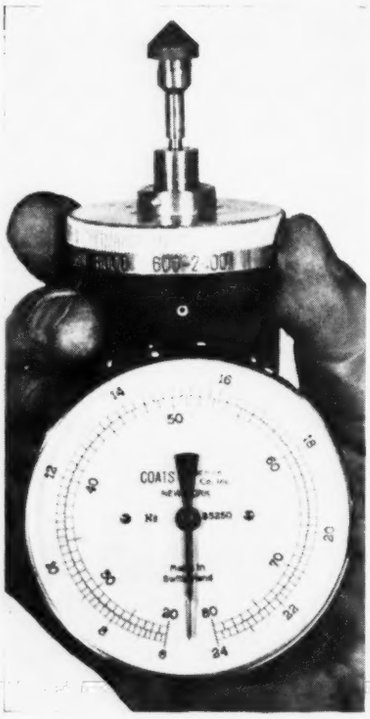
citer. Illustration shows alternator with end shield cover removed. *Kato Engrg Co, Mankato, Minn.*

Resistors

OHMITE WIRE-WOUND, vitreous-enameled resistors available in "live" and "dead" bracket types for special applications. "Live" bracket type resistors have flexible leads connected to tin-plated brass brackets. They are designed for mounting and making electrical connection by bolting slotted brackets to panel terminals. "Dead"-bracket resistors are mounted by bolting to brackets. Electrical connections are made separately to lugs. Brackets for 1, 2 or 3 resistors are mounted to resistors by means of through-bolts. Both types are used for signal circuits, electrical refrigeration controls, storage battery charging, switchboards and other applications. *Ohmite Mfg Co, 4835 Flournoy St, Chicago, Ill.*

Hand Tachometer

CENTRIFUGAL HAND TACHOMETER, while similar in appearance, should not be confused with type shown originally on page 103, June, 1938, POWER. Former type hand made almost two full revolutions of dial



"STANDCO" PILLOW BLOCKS

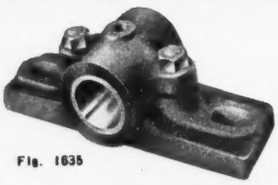


Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

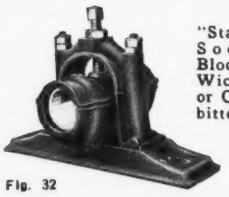


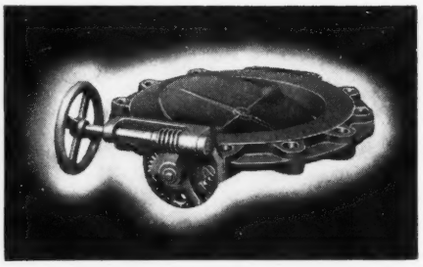
Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA

Boston, Detroit, Indianapolis — Box 577 — Chicago, St. Louis, San Francisco



If it's a Blast Gate ROCKWELL makes it

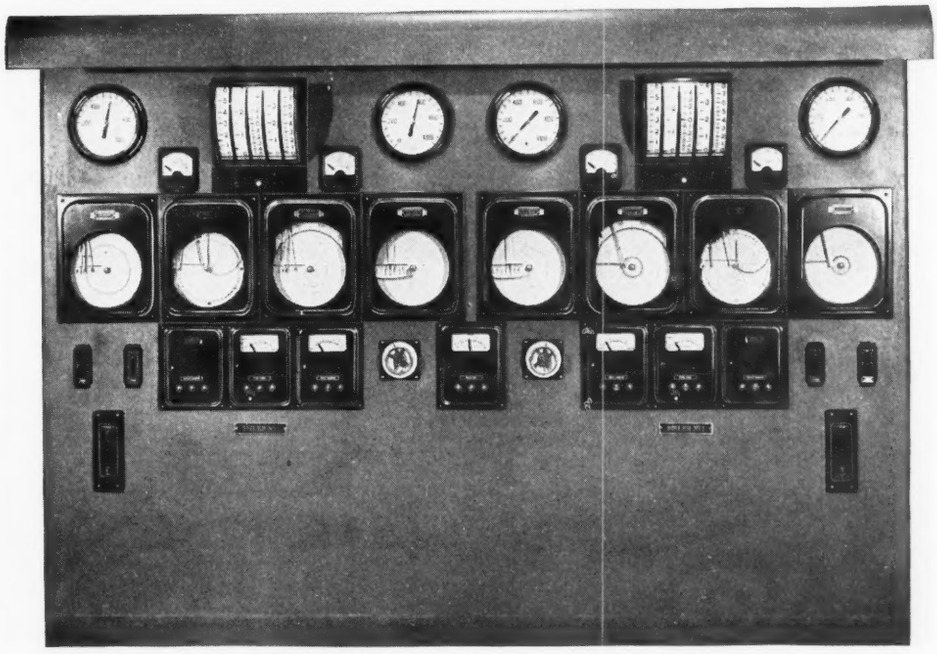
ROCKWELL'S complete line of Blast Gates includes all types: Slide, Kwikleen, Wafer, and Butterfly, in sizes up to 48". They are quick and easy to operate—strong, light, and durable. They can be supplied in monel, bronze, stainless steel and other alloys to meet individual requirements.

Send for Catalog No. 4020

W. S. ROCKWELL COMPANY
Blast Gate Division
50 CHURCH STREET NEW YORK, N. Y.

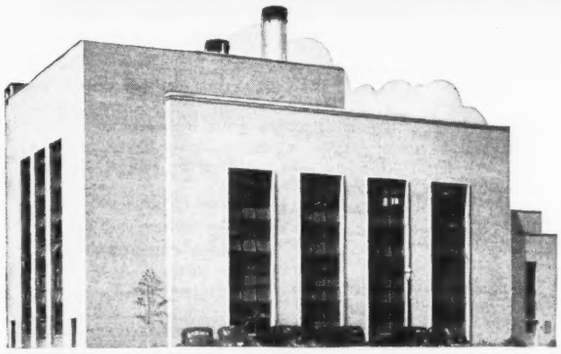
OK IN THE OLD PLANT

HAYS Repeats in the NEW!



HAYS *Automatic* COMBUSTION CONTROL...

was so satisfactory in the old municipal light plant at Holland, Michigan, that it was chosen for the new million-and-a-half dollar plant now serving this thriving little city.



The new million-and-a-half dollar municipal light plant at Holland, Michigan, one of the most modern and efficient in the U. S. A.

THE practicability of automatic control of combustion in the operation of a steam generating plant is strikingly demonstrated in this model light plant. Two identical sets of equipment, each consisting of a steam generating unit and a 7500 kw. turbine generator, with all their associated auxiliaries, may be operated singly (usually alternating) or together. It is designed for 550 lbs. gage pressure and 825° F. total temperature. The load varies widely but even at its lightest the CO_2 percentage is maintained at 15% with as high as 17% CO_2 at high load. Steam pressure remains constant. Another case proving the value of Hays Automatic Combustion Control in securing test operating efficiency every minute of the day and night! Write for full particulars.

Engineers please note:

Tear off the bottom of this ad and send with your name and address to The Hays Corporation and we will send you copy of "Automatic Combustion Control and Its Relation to Lower Steam Costs."

The HAYS CORPORATION

SINCE 1901 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A

Strip Transformers This FAST, LOW-COST Way!

Did you know that you can strip paint from a 2500 kva boiler-tube type transformer in one day's time? If you find this job requires tedious, time-consuming hand scraping and chipping, use the Oakite Hot Flow-On Method that is so successfully helping power plant superintendents and engineers do this job **FASTER.**

Yes . . . you can remove from 10 to 20 paint coats in one operation right down to bare metal! Surfaces are left in perfect condition to take priming and subsequent coats of paint. Method reaches all exposed and inaccessible portions of transformers . . . and avoids many occupational hazards previously associated with this work.

LET US PROVE IT!

Why not let us demonstrate what this remarkable, widely used method can do for you? Since you have everything to gain . . . nothing to lose . . . won't you write today?

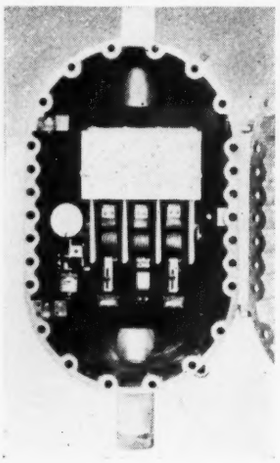
OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

in each speed range, requiring weak torsion spring in governor for first revolution and strong torsion spring for second revolution. New instrument has cross pendulum and five speeds. While in old instrument speed ratio was 1:12 in each range, new one keeps ratio down to 1:4 in each measuring range. *Coats Machine Tool Co, Inc, 75 West St, New York, N. Y.*

Air Circuit Breaker

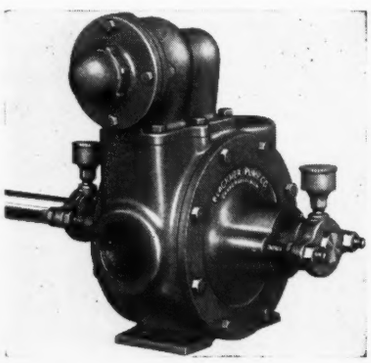
G-E TYPE AE-1B AIR CIRCUIT BREAKERS NOW available in explosion proof boxes for applications in all groups of Class 1 locations as defined in National Electrical Code. Breaker is rated 25,000 amp interrupting



capacity, 600 volts ac, 250 v dc, for continuous currents up to 600 amp. Unit is mounted on hinges in box, and with cover open is completely accessible for inspection and maintenance. Similar to other breakers in line, manually operated unit may be closed with turn of pistol-grip handle; electrically operated unit by push-button on breaker or by control switch in remote location. *General Electric Co, Schenectady, N. Y.*

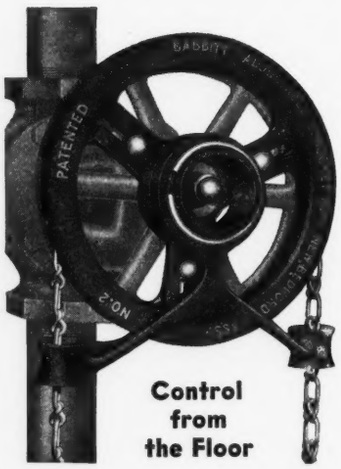
Rotary Pump

BLACKMER PUMP EMPLOYS basic "bucket" design and operates on same principle as all Blackmer "bucket" pumps, but has



certain refinements which are said to increase efficiency, make pump more efficient in operation and increase life of buckets. According to manufacturer, new pump has

Make Your Overhead Valves SAFE And Easy to Reach---



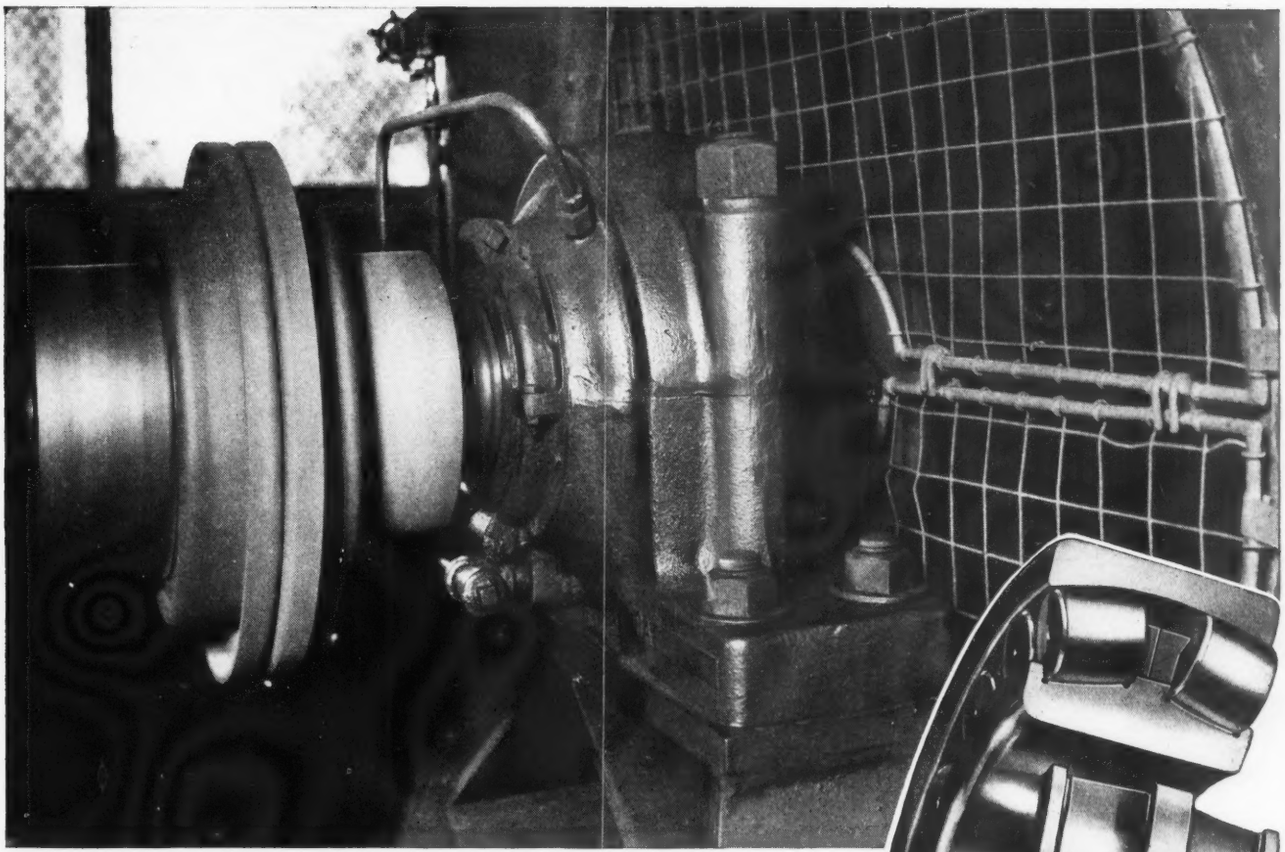
With the Babbitt Rim for Valves you eliminate danger and banish the step-ladder. You can now place your valves wherever they come economically and conveniently. They fit any valve. Let us tell you more about them. Write today.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass.

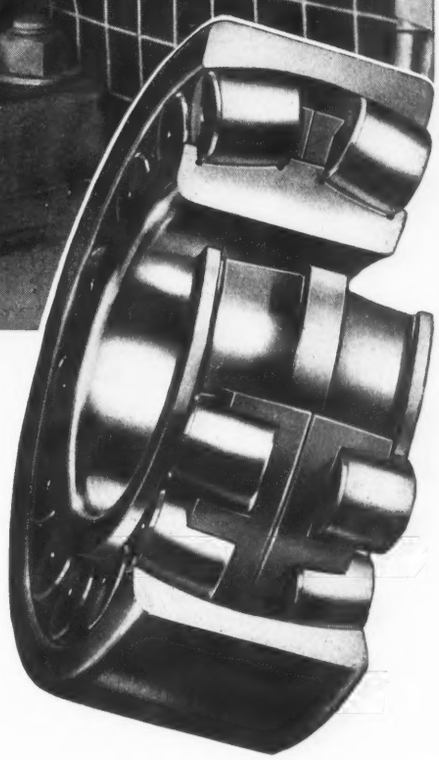
SAFE TRACTION *with* BATESGRATES
ELECTRICALLY PRESSURE WELDED

Non-slip, sharp top edge, self-cleaning cross bars like the ridge of a roof give you the maximum in safe traction. Other features your Batesgrate dollars buy are—maximum open area for light and air—no grooves or rough burned metal to catch grease or dirt—fillet weld, the strongest type—no cracks, joints, or crevices, therefore, easily maintained—smooth, clean appearance. Get all the important details from Catalog No. 937—Write today.

WHEN YOU NEED GRATES
***Specify* BATES**
FOR LONG-TIME ECONOMY
WALTER BATES COMPANY
208 S. LA SALLE ST., CHICAGO, ILL.



SKF Pillow Block on forced draft end of Duplex Fan, BUILT BY B. F. STURTEVANT CO. and installed in the power plant of Gulf State Utilities Company's Louisiana Station. Air velocity, 5000 feet per minute; rotor weight, 1400 pounds; speed, 1280 r.p.m.; h.p., 695.



No Danger

FROM OIL SUCTION

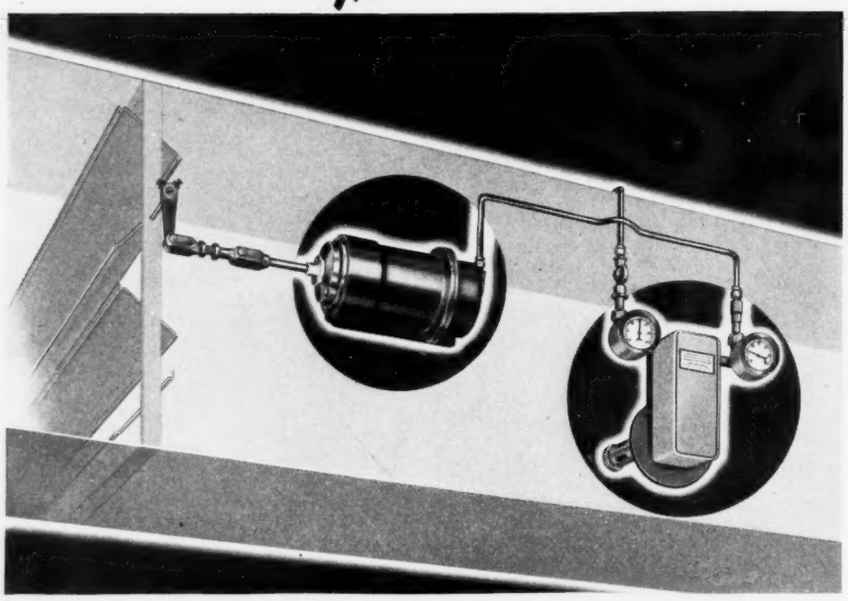
Air currents can't suck oil out of this special air-balanced SKF Pillow Block. That's because the housing is designed to equalize the air pressure on both sides, thus preventing oil suction through the seals—another SKF answer to important bearing problems. Turn *your* bearing problems over to SKF, and forget them.

SKF INDUSTRIES, INC., PHILA.

4757

ROLLER SKF BEARINGS

JOHNSON *Long Travel* Damper Motors



COMMANDED BY JOHNSON *Jeweled Movement* THERMOSTATS

Johnson "Piston Type" Damper Motors are engineered specially for the particular job of controlling dampers G-R-A-D-U-A-L-L-Y. Emphatically, they are not just another valve operator adapted to other service. Designed from the viewpoint of dampers only, these Johnson "long-travel" motors improve the whole automatic control installation. Direct connection between motor and damper, without levers, means *more power!* Cylinder and piston arrangement provides *more movement* than is possible with conventional damper operators! When controlled by Johnson smooth-operating *Jeweled Movement* Thermostats, with adjustable sensitivity, the result is precise relationship between controlling instrument and controlled device. Accurate positioning of dampers under all conditions... Send for Bulletin D-251 which describes Johnson Piston Type Damper Motors or Bulletin D-261 which provides information on the Johnson Pilot Mechanism.

LOOK AT THE WHOLE SYSTEM

Efficient devices are valuable only if they function perfectly as part of the whole. Consequently, Johnson stresses the importance of complete control systems, designs, manufactures, installs, and services its own installations. A nation-wide organization stands ready to supply information on installing new or rehabilitating existing systems of automatic control. Ask for an estimate.

JOHNSON

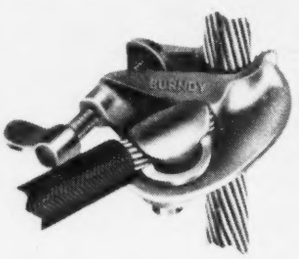
Automatic TEMPERATURE AND AIR CONDITIONING *Control*

JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. AND BRANCHES IN PRINCIPAL CITIES

been tested on wide variety of liquids ranging in viscosity from naphtha to blackstrap molasses and has performed satisfactorily. Pump will be furnished without removable liner for handling clean liquids. Standard units are furnished as single or twin pumps with single-reduction-gear drive or a single pump direct-connected to gear head motor. *Blackmer Pump Co, Grand Rapids, Mich.*

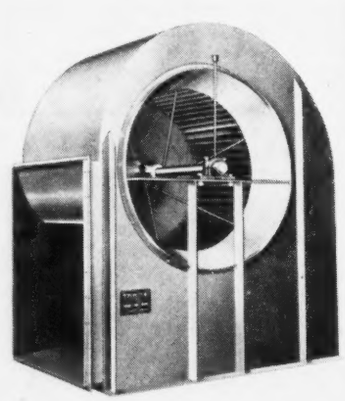
Connector

BURNDY "HOTTAP" especially suited to taking taps from either cable or flat bar, or may be used for grounding, temporary taps, and jumping equipment being repaired or replaced. Jaws which grip "hot" conductor have grooved contacts which are designed to clamp cable, and serrated contacts which may be used to clamp flat bar securely. On tap, rotatable eye clamping element is used, permitting tap conductor to be connected to Hottap at any angle. *Burndy Engrg Co, 459 East 133d St, New York, N. Y.*



Blower Fan

BACKWARD AND FORWARD-CURVED BLADES featured in line of blower fans for heating, cooling and ventilating applications. Trane Type FC fan wheels are of forward-curved,

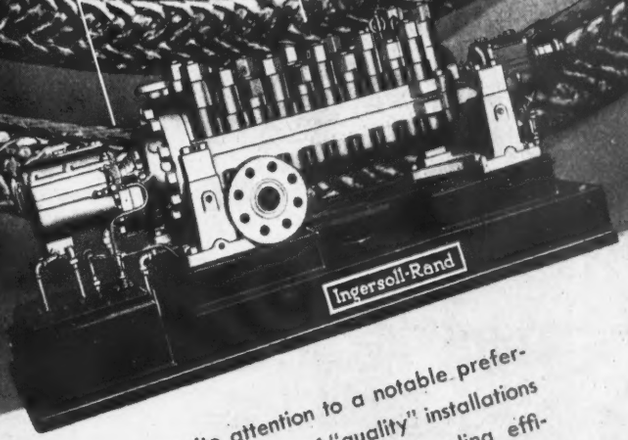


multi-blade type, and have been developed to conserve space, lessen power requirements, eliminate noise, and yet deliver full capacity at lowest possible speed. BI wheels have 12 backward-curved blades with special accurately formed rim. Also included in line are direct-connected units for general utility duty, supply and ex-

BULLSEYE *by a* PAIR OF ACES

PUMP *by* INGERSOLL-RAND

PACKING *by* JOHN CRANE



Abstract OF INSTALLATION

PROBLEM:
Pumping boiler-feed water at 405° F to 420° F; discharge pressure 1550 to 1700 pounds; suction pressure 450 to 500 pounds . . . .

EQUIPMENT:
Ingersoll-Rand Cameron Class CHT Multi-Stage Vertically Split Barrel-type heavy duty, high pressure Boiler Feed Pump . . . .

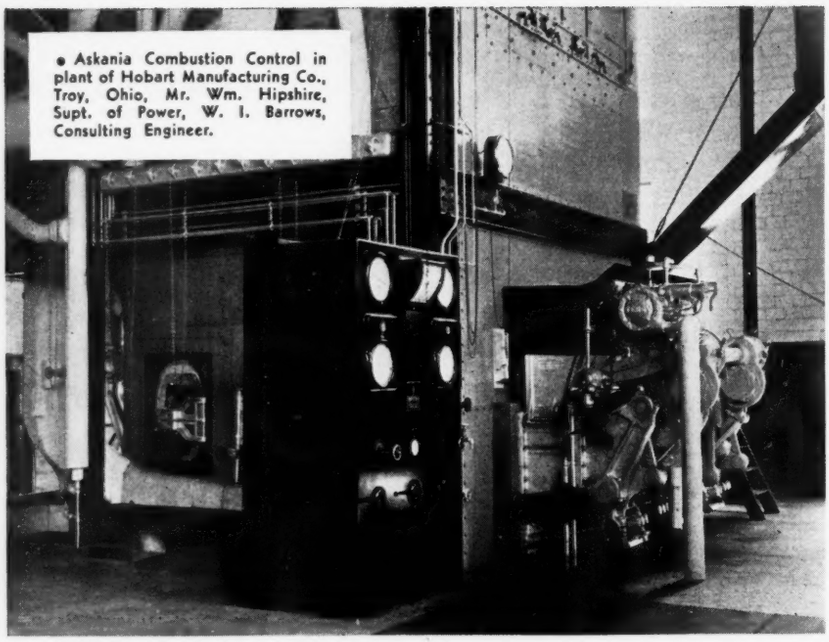
PACKING ADAPTATION:
John Crane Style 804-MBF on Nitralloy sleeves . . . .

SOLUTION:
100% performance . . . .

LOCATION:
(Data on request).

. . . . Opportunity is taken here to invite attention to a notable preference for John Crane Packings—one of a long series of "quality" installations where John Crane Style Packing demonstrated spectacular sealing efficiency . . . Yes, more than 98% of the "incurable" problems submitted to our technical staff have been solved. John Crane recommendations, based upon scientific analysis and procedure are offered without obligation.

CRANE PACKING COMPANY, CHICAGO, U S A
CRANE PACKING COMPANY, LIMITED, HAMILTON, ONTARIO, CANADA



• Askania Combustion Control in plant of Hobart Manufacturing Co., Troy, Ohio, Mr. Wm. Hipshire, Supt. of Power, W. I. Barrows, Consulting Engineer.

And the REAL record is not on the CHARTS

DAY after day the recorder charts in this Askania equipped power plant of the Hobart Manufacturing Co., Troy, Ohio, have shown a remarkable combustion efficiency—a constant CO_2 of 13.2 to 13.4, under a widely fluctuating load condition.

But the most important characteristic of Askania Control is not recorded on charts. It is found in the maintenance record—told and written to us by engineers. "It maintains its adjustment day after day," writes one operating man. "We don't have to work on it," writes another.

This characteristic is *inherent*. The Askania Jet Pipe Principle not only means greater sensitivity and greater stability of control; it also means greater *simplicity* of control. Naturally the same number of dollars buy more quality in *simple* equipment than they could buy in complicated equipment. Since oil is used as an operating medium, all parts literally "run in oil" and every adjustment has the power and certainty of hydraulic operation.

Let us cite plant records that prove Askania control to be not only the best control, but, in the long run, the *cheapest* control!

ASKANIA CHICAGO

ASKANIA REGULATOR COMPANY
Corner 16th and Michigan, Chicago, Illinois

ASKANIA *Combustion* CONTROL

haust. Housings are convertible for various standard directions of discharge, while capacities range from 295 to 4500 cfm. *Trane Co, La Crosse, Wis.*

Hand Tachometer

TO ELIMINATE UNDESIRABLE FEATURES of conventional dc tachometer, ac tachometer now developed. No brushes or commutator used in non-sparking generator unit. Ac voltage generated is rectified and in-

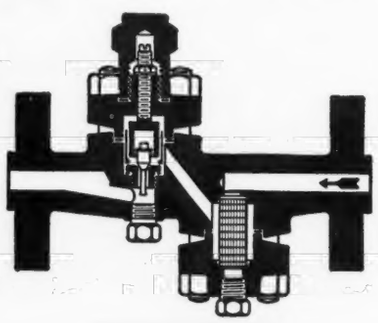
dicated in terms of rotational or linear speeds. Indicating instrument on left can be calibrated in revolutions per minute, feet per minute, gpm, or other units, depending on application. In illustration, laminated rotor features of generator are being pointed out. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Stop Nut

THIN-HEX STOP NUT is for use on shear bolts where high degree of stress is lateral, and for general application to light and medium stress fastenings. As in standard-hex Elastic Stop Nuts, self-locking action is accomplished by a vulcanized fibre collar, built into nut head. Tough bone-like material resists entry of bolt, thus forcing nut outward and taking up all thread play. Nuts are available in steel, brass and aluminum, in complete range of standard sizes. *Elastic Stop Nut Corp, 2332 Vauxhall Rd, Union, N. J.*

Steam Trap

YARWAY IMPULSE TRAP, superpressure type, is of high-pressure, flanged end, or welding socket end, bolted-bonnet design, with integral strainer. Working parts are similar to those in standard impulse trap, in which opening and closing of valve is governed

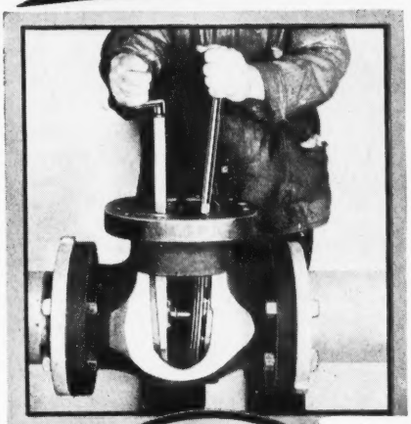


SUPERPRESSURE TYPE

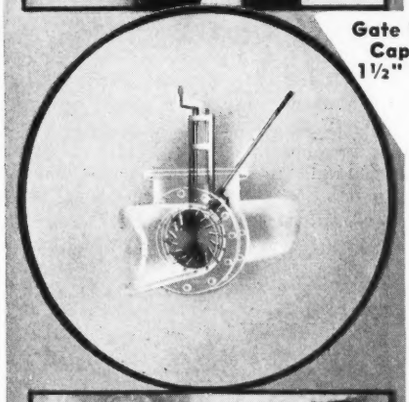
MAKE GLOBE GATE and PUMP VALVES
...as good as New
...at a fraction of the cost

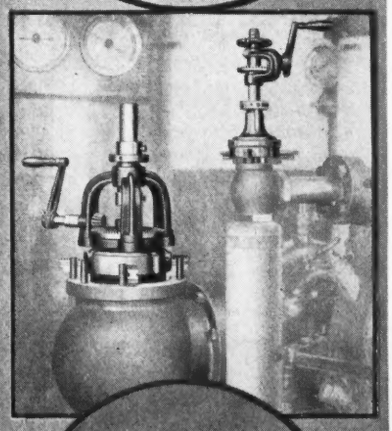
RESEAT YOUR VALVES with DEXTER

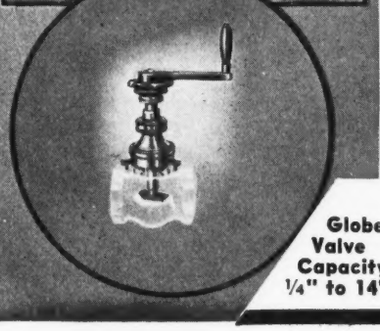
VALVE RESEATING EQUIPMENT



Gate Valve Capacity 1½" to 48"







Globe Valve Capacity ¼" to 14"

● Modern Valve reseating with Dexter Valve Reseating Machines cuts your valve maintenance costs. Reseating costs but a small fraction of a new valve. A Dexter reseated job will last as long as a new valve. You avoid wasteful labor costs, expensive shutdowns . . . and the cost of remaking tight pipe connections, which so often disturbs elbows and joints, causing leaks afterwards. You can reseat your valves a dozen or more times . . . and then start all over again with a new seat . . . without once removing the valve! Cutting blades are available for all types of metals.

THE COST OF NEGLECT—

SIZE OF OPENING	AIR 100 LBS. PRESSURE		STEAM 100 LBS. PRESSURE		WATER 40 LBS. PRESSURE	
	CU. FT. WASTED PER MONTH	COST AT 10c PER M.	LBS. WASTED PER MONTH	COST AT 60c PER M.	GAL. WASTED PER MONTH	COST AT 15½c PER M
3/8	9,979,200	$997.92	460,000	$276.00	692,400	$108.00
1/4	4,449,600	444.96	203,000	121.80	307,700	48.00
1/8	1,114,560	111.46	50,500	30.30	76,900	12.00
1/16	278,640	27.86	12,750	7.65	19,200	3.00
1/32	69,552	6.96	3,175	1.91	4,800	0.80

TIGHT VALVES STOP LEAKS . . . SAVE MONEY

Dexter Valve Reseating Machines are easily and quickly operated, reliable, efficient and durable. They are the result of 50 years of specializing in precision tools for repairing valves. Send today for booklet describing the savings Dexter Valve Reseating Machines will effect for you. Use the coupon!

THE LEAVITT MACHINE CO.

ORANGE, MASS.

Sure! **YOU CAN SHOW ME HOW I CAN CUT MY VALVE COSTS!**

THE LEAVITT MACHINE CO., ORANGE, MASS.

I want to know more about how Dexter Valve Reseating Machines "deliver the goods" in reducing valve and maintenance costs.

Company.....

Name.....

Title.....

Address.....

. . . and the night shift production was lost!

lights OUT . . . power OFF . . . production STOPPED, right in the shank of the evening. All because a main feeder that used to work 40 hours a week couldn't take overloads 24 hours a day, 7 days a week, *week after week.*

It can happen in *any plant* that's turning night into day to get out production. Here's how. To begin with, the wire in old circuits is apt to be dried out with age and in even worse condition where it runs too close to boilers, steam lines, etc. Then, extensions of existing feeders and too many additional branches cause overloads, overheated conductors and insulation breakdown. And, finally, continuous 24-hour operation boosts circuit loads 'way up and keeps them there, ready to make trouble when you least expect it — unless you wire with Rockbestos *permanently insulated* wires for greater carrying capacity.

Every wire of the 118 standard constructions in the Rockbestos line has what you need to prevent production delays caused by wire failure. They are heatproof, fireproof and resistant to moisture, oil, grease and corrosive fumes. Send for our catalog and learn more about them. Rockbestos Products Corporation, 803 Nicoll St., New Haven, Conn.

1. Rockbestos A.V.C. Boiler Room and Lighting Wire
2. Rockbestos A.V.C. Power Cable
3. Rockbestos All-Asbestos Power and Rheostat Cable

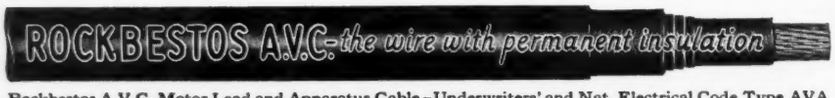
Numbers 1 and 2, Underwriters' and N.E. Code–Type AVA–max. operating temperature 230°F., number 3, Type AI, max. operating temperature 257°F.

TEN TESTED ROCKBESTOS VALUES that will pay you dividends

1. HEATPROOF
2. FIREPROOF
3. PERMANENT
4. Lower maintenance cost
5. Resists heat and vibration
6. Saves work
7. Oil, Grease and Moisture resistant
8. High overload capacity
9. Permanently flexible
10. Greater carrying capacity

Also refer to McGraw-Hill Electrical Buyers Reference

New York Pittsburgh Buffalo St. Louis Cleveland Los Angeles Detroit San Francisco Chicago Portland, Ore. Seattle

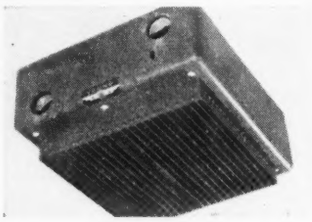


Rockbestos A.V.C. Motor Lead and Apparatus Cable–Underwriters' and Nat. Electrical Code Type AVA –one of 118 different permanently insulated wires.

by changes in pressure in control chamber above valve piston. Medium-temperature condensate reduces chamber pressure and valve opens; high-temperature condensate increases chamber pressure and valve closes. Superpressure trap built for steam pressures up to 1500 lb, temperatures to 900 F. Important feature for high-pressure service is positive closing of main valve in presence of wet, saturated or superheated steam. *Yarnall-Waring Co, Chestnut Hill, Philadelphia, Pa.*

Unit Heater

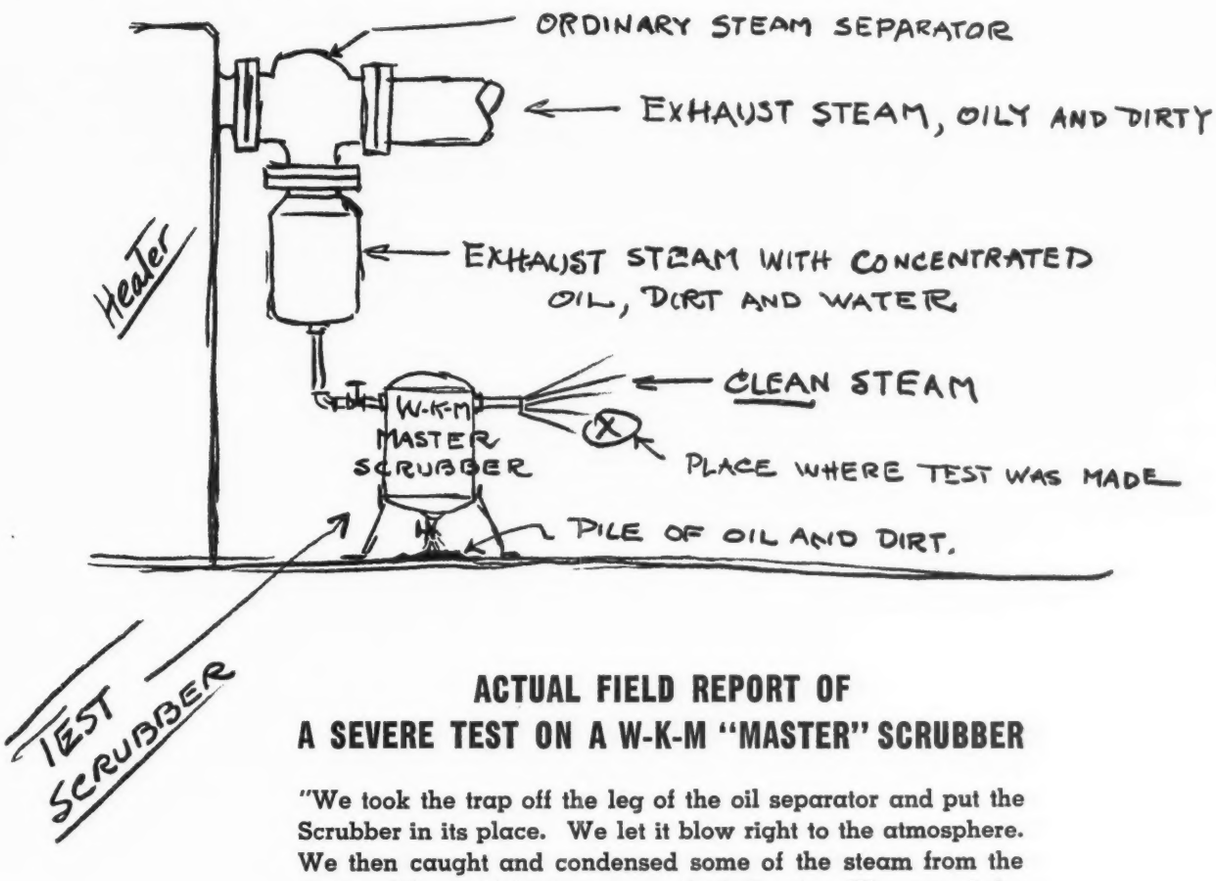
VERTIFLOW UNIT HEATER has well-known Young heating element equipped with 1-piece cast-iron headers into which special alloy tubes are expanded, rolled and ferruled. Heating element is split in center with supply and return headers on same side, but at different levels, to provide natural draining of condensate. Motors may be of constant or variable speed, depending on requirements. Large propeller-type fans give maximum air delivery at low power cost. Casing is formed with round corners from heavy-gage sheet steel. All types provided with mounting-holes tapped for hanger rods on each corner of unit. Any type of diffuser selected can be easily fastened to casing bottom. *Young Radiator Co, Racine, Wis.*



Splashproof Motor

TRI-CLAD MOTOR, splashproof, ball-bearing, polyphase-induction type, now announced in sizes from 1 to 15 hp, supplementing recently announced Tri-clad line. Ventilated openings in stator frame and end shields are baffled to block entrance of splashing liquids. Another arrangement of cast baffles within side openings of stator frame blocks splashing from side. *General Electric Co, Schenectady, N. Y.*

FIELD SERVICE REPORT



ACTUAL FIELD REPORT OF A SEVERE TEST ON A W-K-M "MASTER" SCRUBBER

"We took the trap off the leg of the oil separator and put the Scrubber in its place. We let it blow right to the atmosphere. We then caught and condensed some of the steam from the outlet. We could find no trace of oil therein. We poured the condensate through a clean cloth and it left no sign of oil on the cloth. We put a piece of white paper in the steam from the outlet and got no sign of oil on the white paper. We did get a pool of very thick oil and water on the floor from the drain. There was enough oil in it to build up between 1/3 and 1/2" in thickness on the cement floor while the water ran right off to the sewer."

COMPARABLE QUALITY OBTAINED ON GAS AND AIR

BRADSHAW & CO., 530 Fourth Ave., Pittsburgh, Pa.

Gentlemen: Without obligation, you may send me the bulletin fully describing the W.K.M. Master Scrubber, for:

____STEAM ____AIR ____GAS

Name ____ Company ____ Address ____ City ____ State ____

(PLEASE PRINT)

10

BUYING MORE COAL THESE DAYS? . . .

Slash your coal bills!

. . . Pay only for B.T.U.'s received and get this information accurately with the . . . . .

IMPROVED STURTEVANT

Automatic

COAL CRUSHER *and* SAMPLER

If you're running your plant day and night to supply power for defense production, Sturtevant offers you an opportunity to make real savings in your coal buying. Here's how:

Feed your coal and coke into the Improved Sturtevant Automatic Coal Crusher and Sampler and get samples that are truly representative of all material passed through, crushed to a fineness of practically all minus 8 mesh screen size. Provision is made to obtain 5, 10 or 15% samples as desired.

32 HAND OPERATIONS ELIMINATED

By the Sturtevant method—32 of the 34 tedious operations ordinarily required by hand sampling are eliminated. In addition, greater accuracy and speed of sampling are assured. Ability to obtain and compare accurate samples of every barge or car of coal enable you to know exactly what you are paying for in terms of BTU's and thus determine the most economical coal for your purpose—and you *get* this important information before you burn it—insuring better boiler performance, lower maintenance and savings in your fuel bill. INVESTIGATE TODAY: SEND FOR BULLETIN 85.

For Savings . . .

"SAMPLE YOUR COAL BEFORE YOU BURN IT"

Sturtevant Mill Co.

103 Clayton St., Dorchester, Boston, Mass.

Gas Engine Test Data

(Continued from page 122)

which have ratios—net to high values—of 92.4 and 89.7 respectively. A potential error of 2.7% is present here if only the high value is considered."

(Editor's Note): The new Power Test Code for Internal-Combustion Engines, now in preparation, requires that *both* higher and lower heating values be used for gas engines.

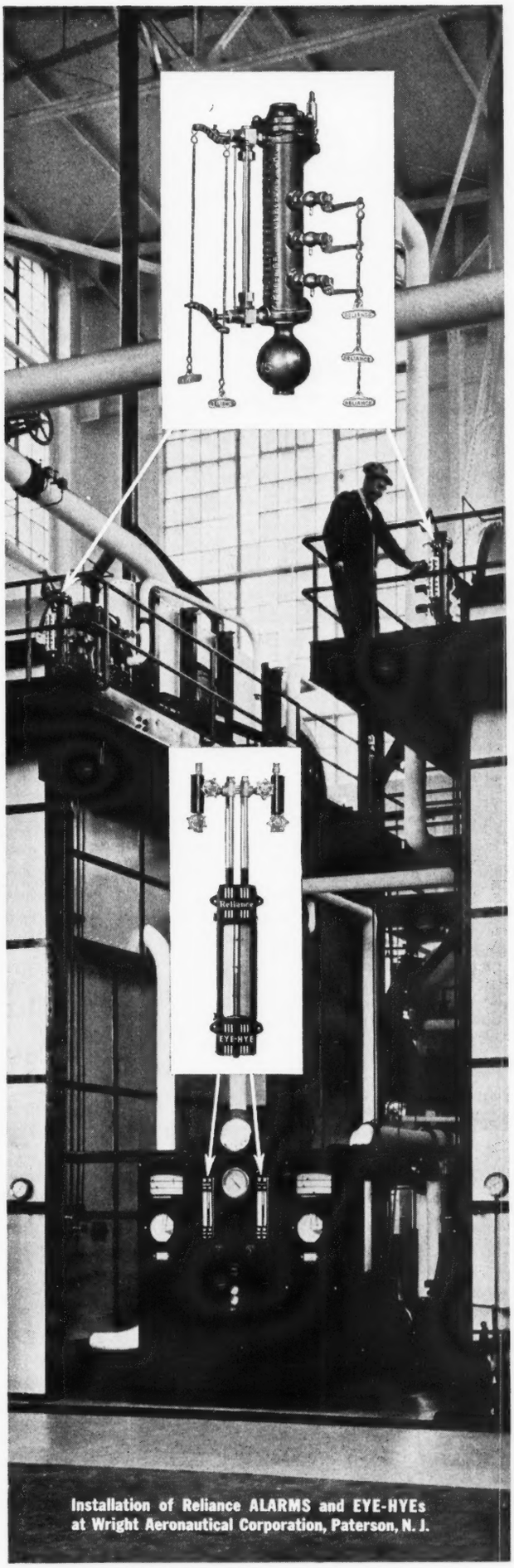
Mathematical Error?

(Cross): *"In these particular tests apparently the low heat value or a value approximating it, was used. For example, in the 110% load test, the table states that the "corrected cu ft of gas per hour" was 11,770 and that the high heat value was 1149 Btu. In other words, a total of 11,770 × 1149 = 13,523,730 Btu. But note that the table gives this product under the heading "Millions of Btu per hr, net," as 12,300,000. The tabulated value is then 10% in error. Unless this is a mathematical error, it would appear that those making the test deducted 10% from the high heat value to offset the loss due to water vapor in the combustion gas—a totally unjustified procedure. For the time being, however, the value 12,300,000 will be used in order to point out other errors."*

(Editor's Note): If Mr. Cross had looked closely at the table of test results he would have seen that on the same line with the higher heating value, given as 1149 Btu, there is also given a net value, 1044 Btu. Multiplying 11,770 by 1044 gives the value of 12,300,000 Btu. The calculations definitely are based on the lower heating value, for reasons given in the preceding item, and no error is involved.

Generator Efficiency

(Cross): *"The generator efficiency is stated to be 95.2% although specifications of identical Westinghouse generators call for 94.3% efficiency. Now this 94.3% efficiency (or 95.2% if one uses the value in the table) does* NOT *include I^2R losses in stator and rotor, coil losses, exciter losses, field rheostat losses, windage losses, etc. According to the AIEE, these losses, (unmeasurable in ordinary test) should entail a deduction of 1.75% from the full-load generator efficiency for generator efficiencies ranging from 94% to 96%. The net efficiency of the generator in question is, then, 95.2 − 1.75 = 93.45% (and is*



Installation of Reliance ALARMS and EYE-HYEs at Wright Aeronautical Corporation, Paterson, N. J.

Avoid Costly Boiler Water Accidents

No crippled production with the

RELIANCE SAFETY TEAM

SOUND CHECK ✓ ALARM Water Column

SIGHT CHECK ✓ EYE-HYE Remote Gage

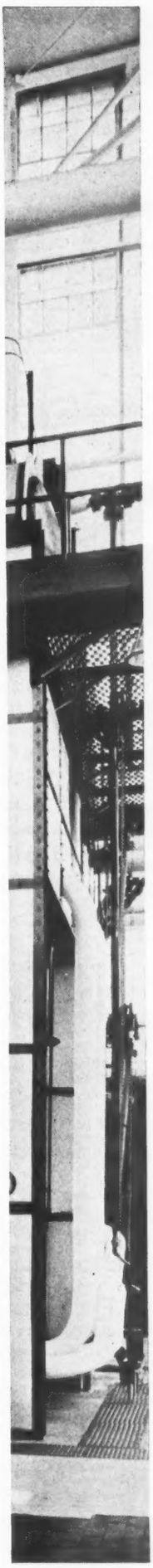
WHEN these two Reliance devices safeguard your power by assuring efficient water level supervision, they doubly safeguard your production and earnings—preventing conditions that lead to costly accidents and serious power interruptions.

You can see this efficient Safety Team in hundreds of boiler rooms everywhere, admirably illustrated by the new No. 2 Plant of the Wright Aeronautical Corporation. The ALARM, an old "stand-by" found on the majority of boilers since 1884, is the sturdy never-failing SOUND check that warns against unsafe low or high water. EYE-HYE, only four years old but already demanded by many engineers as basic boiler-room control equipment, brings the gage reading down for easy, frequent SIGHT check. Easy to install—always accurate.

The small cost of Reliance Safety Team protection can't approach the worth to you of this two-way guard against water level worry. Write today for ALARM and EYE-HYE Bulletins.

THE RELIANCE GAUGE COLUMN CO.
5902 CARNEGIE AVE., CLEVELAND, OHIO

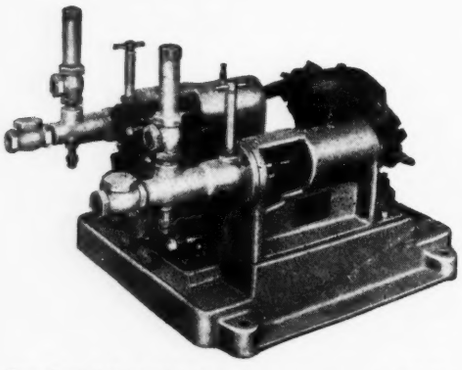
Reliance
Boiler Safety Devices since 1884



PROTECT YOUR STEAM GENERATING EQUIPMENT BY POSITIVE PROPORTIONING WITH %PROPORTIONEERS% CHEMICAL FEEDERS

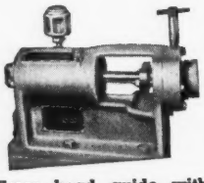
Complete chemical treating and feeding methods for the power plant include the handling of phosphates, sulphites, sulphates, sulphuric acid, etc. by:

1. **Constant rate Adjust-O-Feeder for low and high pressure service.**
2. **Shot feed Adjust-O-Feeder with manually adjustable time cycle control.**
3. **Flow-proportional Adjust-O-Feeder or Treet-O-Unit with control from—(a) reciprocating boiler feed pumps—(b) electric motor-driven control from either mechanical or Venturi meters.**



Standard Adjust-O-Feeder for pressures up to 250 lbs. Capacities from 5 gph. to 10 gpm.

The accuracy and performance of a proportioning pump depend on these features:



Cross head guide with visible stroke length scale.

Micrometer crank arm with adjusting screw.

Connecting rod assembly showing needle bearings.

Use %Proportioneers% Chemical Feeders for general plant water supply; and deaerator treatment for direct feed to boiler drums. Send for Bulletin SM 122A

% PROPORTIONEERS, INC. %

16 CODDING STREET, PROVIDENCE, RHODE ISLAND

probably 94.3 — 1.75 = 92.55% eff.).

(YOUNT): "The generator efficiency was taken from Westinghouse Performance Data #3821, page 2, wherein is given the efficiencies for this type generator at 1/2, 3/4, and 4/4 load and at 80% power factor. These efficiencies include I^2R losses of stator and rotor coils at 75 C, core losses, and stray load losses. Field rheostat losses, exciter losses, and windage losses are not included. These losses may be included by making the adjustments listed below" (page 8 of the same data). The efficiency at full load given herein was 94.3% at 80% pf (from page 2) and adjustments made for our particular condition as set forth in page 8:

"(a) Addition of 1.5% to obtain 1.0 pf efficiencies (run was made on water rheostat and, therefore, 1.0 pf). (b) Subtraction of 1.2 × 0.4 or 0.48% for exciter losses when operating at 1.0 pf. (c) Subtraction of 0.4 × 0.5 or 0.2% for windage alone where windage and friction are 0.5% (the generator is supported by bearings inside the engines so no friction can be rightly charged against the generator). (d) No rheostat losses were charged because excitation was not taken from a bus but directly from the engine's own chain-driven exciter.

"Therefore, the full-load efficiency becomes 94.3 + 1.5 — 0.48 — 0.2 or 95.12% as shown in the generator efficiency test submitted with the report. Points for 1/4, 1/2, 3/4, and 5/4 loads were taken as given in the same data and then plotted into this curve. Reading the curve will find the efficiency at 110% load to be 95.2.

"We have discussed this with our electrical engineer, E A Murray, and he agrees with the above."

Indicated vs Recorded Kw

(CROSS): *"The statement is made that the indicated kw was 1104. It is assumed that this means the reading of the wattmeter (checked, let us assume, by voltmeters and ammeters). With the indicated kw of 1104, the net kw would be 1104 ÷ 93.45 = 1181 kw. This resolves itself into 1181 ÷ 0.746 = 1583 brake horsepower.*

Incidentally, there is a mathematical error in this item of the table. For 1104 ÷ 95.2 = 1160 gross kw, if we ignore the AIEE deduction of 1.75% and use 95.2% generator efficiency, and we should have 1160 ÷ 0.746 = 1555 brake horsepower and not 1620 as given in the table."

(Editor's Note): Here the error is ours. In abstracting the complete test

These PRECISION QUARTER-MARKS make WeldELLS WORTH MORE

IN developing WeldELLS we gave a lot of consideration to the common-sense principle that the *easier* it is to handle a job, the *better* it will be handled. The precision quarter-marks at each end of every WeldELL are one of many examples of this.

There are many times when these convenient reference marks save a lot of troublesome figuring—help eliminate errors—make it easier to turn out a perfect job. At such times this feature alone would justify your selecting WeldELLS. But you also have the seven other sound reasons listed opposite.

Of course it costs us something to provide these betterments that are combined only in WeldELLS, but giving you this added value is only in keeping with principles that Taylor Forge has observed for more than 40 years: First, *sound engineering design—then maximum utility, convenience, and economy.*

Some of these features cut installation costs. Others add to the value of the finished job . . . Yet WeldELLS cost no more.

Write for Taylor Forge Catalog 401. It contains not only complete information on Welding Fittings and Forged Steel Flanges, but also a lot of useful engineering data.

TAYLOR FORGE & PIPE WORKS, General Office & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Building

Taylor Forge

WeldELLS

Seamless Pipe Fittings for Welding

OTHER EXTRA-VALUE FEATURES

You can't ask for a single thing in welding fittings that WeldELLS do not have. No other fittings for pipe welding combine these eight features. In addition to quarter-markings (described opposite) the features are:

1. Seamless — greater strength and uniformity.

2. Tangents—keep weld away from zone of highest stress—simplify lining up.

3. Selective reinforcement—provides uniform strength.

4. Permanent and complete identification marking†—saves time and eliminates errors in shop and fields.

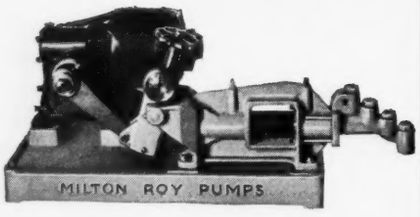
5. Wall thickness never less than specification minimum—assures full strength and long life.

6. Machine tool beveled ends—provides best welding surface and accurate bevel and land.

7. The most complete line of Welding Fittings and Forged Steel Flanges in the World—insures complete and undivided responsibility.

†Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.

MILTON Roy PUMPS
Chemical Feeders
and
Proportioners



Metering Pump With Exact Capacity Control

The capacity of this pump, for handling boiler-treating solutions, is variable from zero to 100% *while in operation.* The micro-adjustment for piston stroke is positive and accurate. A vernier dial permits quick resetting to an *exact duplication of capacity.*

Such accuracy of measurement is made possible by the step-valve construction, with its uniform volumetric efficiency . . . found only in Milton Roy Pumps.

Milton Roy Pumps are built in a wide range of capacities, in all castable or machineable alloys, and in transparent plastics for pumping chemicals such as

- **Sodium Sulfite**
- **Sodium Phosphates**
- **Calgon • Soda Ash**
- **Caustic Soda • Lime**
- **Organic Boiler Water Treatments**

What are your requirements? Write for Bulletins. Ask also for Proportional Feed Diagrams . . . of real value if you have to do with problems of proportioning or measuring.

MILTON ROY PUMPS
1362 E. Mermaid Ave., Chestnut Hill, Phila., Pa.

tabulation for publication, we inadvertently included the *indicated* kw and omitted the kw as measured by the more accurate kw hr recording meter. This reading was 1150 kw and was used in the calculations instead of the 1104 figure. This change makes the 1620 brake horsepower check and no mathematical error is involved.

Mechanical Efficiency

(CROSS): *"In spite of this obvious error, let us return to the main line of reasoning. As shown heretofore, the total brake horsepower is 1583. Since 12,300,000 Btu was used per hr, according to the erroneous value in the table, the Btu per bhp was 12,300,000 ÷ 1583 = 7183 Btu. Since a horsepower hr is equal to 2545 Btu, we apparently have a brake thermal efficiency of 35.6%. An engine of this type should have a mechanical efficiency of 85%, therefore, the indicated thermal efficiency of the engine was 35.6 ÷ 0.85 = 42%."*

(YOUNT): "To digest the criticism thoroughly we must begin with the paradox of correcting the corrector's figures. In the (above) paragraph, the critic states '12,300,000 ÷ 1583 = 7138.' The figure calculates 7765 and corrects the next figure from 35.6% to 32.8%.

"In the (next) paragraph, the critic makes some rather broad assumptions, *ie*, he assumes 85% mechanical efficiency and then sets up a theoretical thermal efficiency therefrom of 42% (which should be 38.6% due to the previous error). We would prefer to believe the mechanical efficiency of the engine to be nearer 90%, and base this belief on actual data obtained on similar engines with indicator cards. This would reduce the indicated thermal efficiency from 38.6% to 36.4%."

Efficiency Comparisons

(CROSS): *"This engine has a compression volume ratio of 4.5. If one will inspect the attached chart, where curve A is the ideal air-cycle efficiency curve for an Otto-cycle engine, it will be seen that the efficiency of the ideal air-cycle Otto engine with this volume ratio is but 43%. This curve is based on the Otto-cycle equation of* $e = 1 - \frac{1}{}$ *In other words, the actual engine showed a thermal efficiency practically equal to the ideal efficiency. Generally engines show an efficiency ratio of about 75%.*

"Curves B, C, and D shown on the chart are results of computations made by Goodenough and Baker, for the ideal indicated thermal efficiency of an Otto

HIGH BONDING STRENGTH

That's what you must look for most in a fire brick cement to assure long lasting furnace constructions. Adamant Fire Brick Cement *has it* . . . this has been definitely proven by impartial laboratory tests made by one of the leading technical institutes. There, the average modulus of 5 test joints showed

ADAMANT
FIRE BRICK CEMENT has a BONDING STRENGTH of
800 lbs. per sq. in. at room temperature. 1270 lbs. per sq. in. at 2600°F.

ADAMANT has a P.C.E. of 3000°F. plus

Adamant has numerous other superior characteristics that make it the preferred cement of many leading firms. If you, too, want a cement that makes joints strong as the brick they bond be sure to use Adamant. Write us today for full details.

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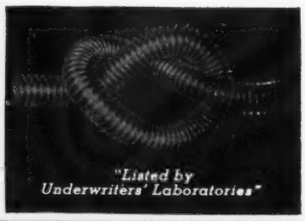
SEAMLESS FLEXIBLE METAL HOSE

Normal Pitch

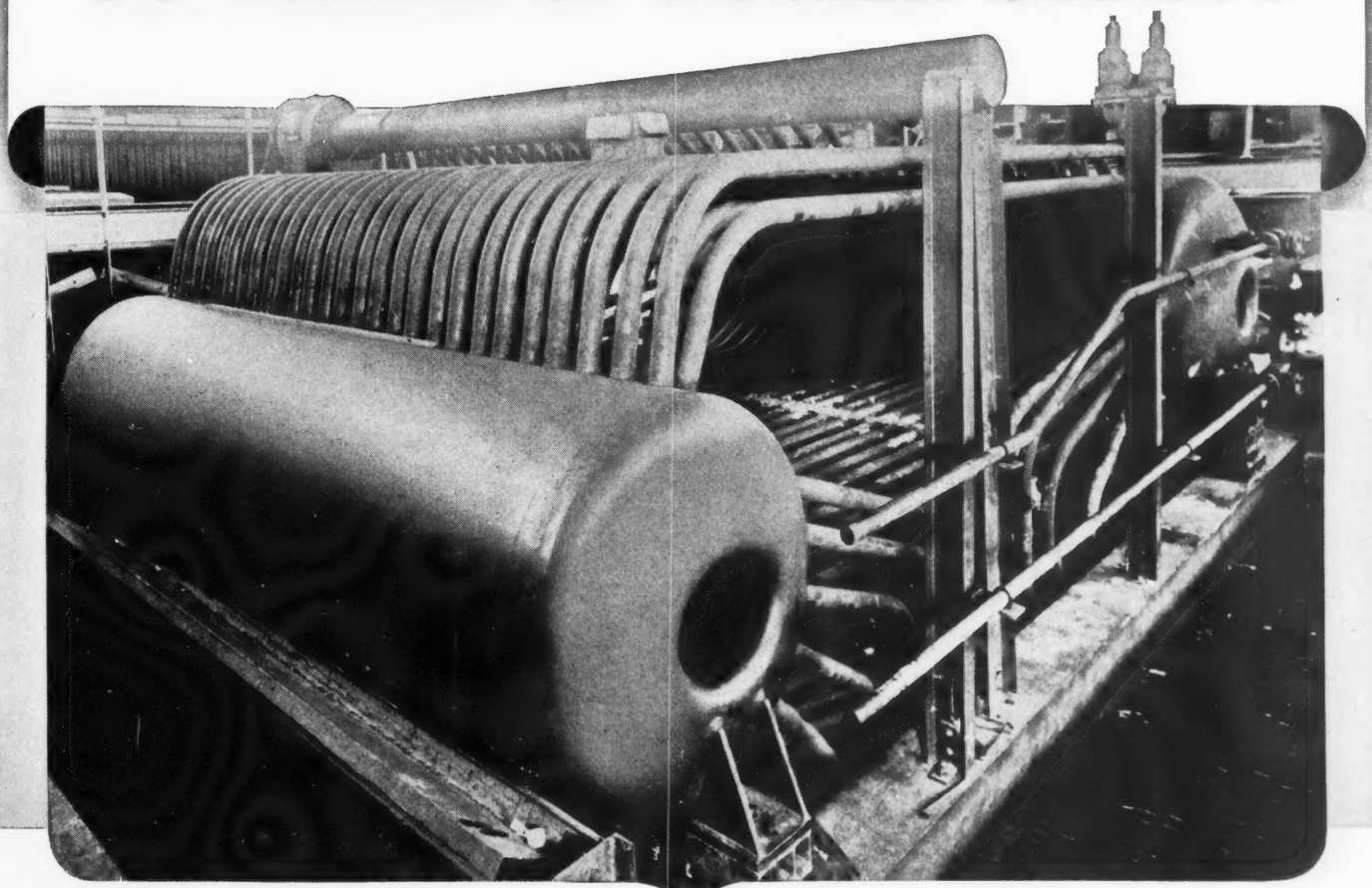
Of seamless, all metal, parallel corrugated, armored construction, in various alloys with renewable type fittings approved for the conveyance of non-solids and non-abrasives in *Aviation, Automotive, Marine, Heating, Air Conditioning, Mining, Power Generation, Plastic and Textile applications* wherein conditions of flexing and expansion between delivering and receiving connections exist. Also available for shielding and exhaust applications.

Close Pitch



METAL HOSE DEPARTMENT
ECLIPSE AVIATION, BENDIX, N. J.
DIVISION OF BENDIX AVIATION CORPORATION

NOW IS THE TIME TO THINK OF BOILER SAFETY



Every day is a day to think of boiler safety—but most important of all times is the day you specify tubes for a new boiler or for retubing an old one. Upon these tubes will depend the operation of your plant.

And when you're thinking of boiler safety, here are a few facts for serious consideration:

Republic ELECTRUNITE Boiler Tubes are made by a *SAFE* process—fully-mechanical, fool-proof electric resistance welding. And the tubes are consistently uniform in diameter, wall thickness, concentricity, ductility and smooth, scale-free surface.

To further insure safety for your boilers, samples taken from every lot of tubes must pass a rigid routine of tests, including expanding, crushing and flattening at the weld.

Finally, ever tube while under vibration must withstand a hydrostatic pressure test within 20% of the minimum yield point of the steel from which it is made. Always above the code requirement, these pressures prove the extra factor of safety in every Republic ELECTRUNITE Tube—yet they are held well below the critical point at which the tube might be weakened.

Now is the time to think of boiler safety—and now is the time to obtain *ALL* the facts about Republic ELECTRUNITE Tubes—facts which every boiler user should have. For the full story, write Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

REPUBLIC STEEL DEFENSE FOR AMERICA

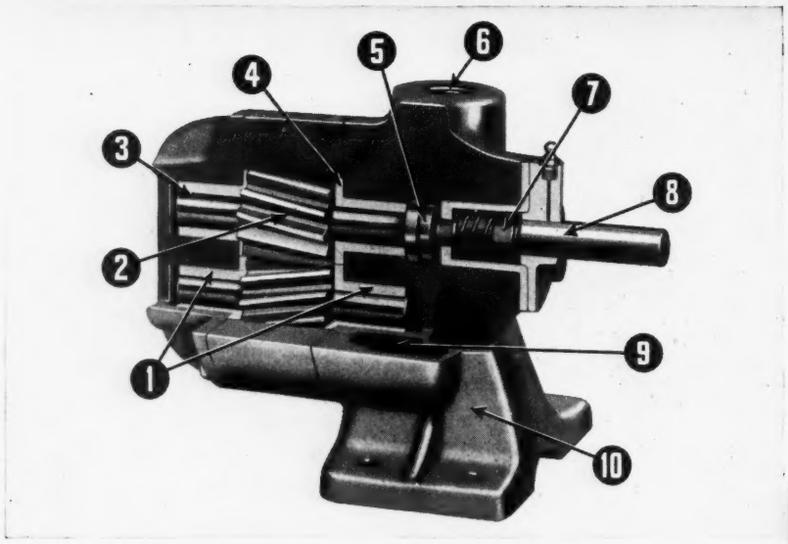
REPUBLIC

REG. U. S. PAT. OFF.

ELECTRUNITE

ELECTRIC RESISTANCE WELDED BOILER, CONDENSER AND HEAT EXCHANGER TUBES

10 GOOD REASONS *for Specifying* ROPER ROTARY PUMPS



Thick or thin—acid or alkali—corrosive or combustible—there is a ROPER to handle any clean liquid. We have pumps standard fitted, bronze fitted and all bronze—capacities from 1 to 1000 gallons per minute—pressures up to 1000 lbs.—speeds up to 1800 r.p.m. —mountings and drives for every practical need.

Demand this HYDRAULICALLY BALANCED seal on every rotary pump you buy. It means the pump will last longer, be quieter in operation, have higher efficiency and give more dependable performance.

Get all the facts about ROPER "hydraulically balanced" PUMPS. Write today for catalog 944 or see our catalog in Sweet's.

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ROCKFORD . . . . ILLINOIS

1. LARGE BRONZE BEARINGS
2. SPIRAL PUMPING GEARS
3. CONSTANT LUBRICATION
4. BRONZE WEAR PLATES
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6. FOUR PIPE OPENINGS
7. MECHANICAL SEAL
8. SPLINED DRIVE SHAFT
9. ALWAYS PRIMED
10. ONE PIECE BACKPLATE

ROPER *Rotary* PUMPS
DEPENDABLE - SINCE 1857

cycle, employing real mixtures of gasoline and air instead of air only which is the condition represented by curve A, taking into account variations in specific heat and of chemical equilibrium. Curve E is the best recorded indicated thermal efficiency of a high-grade Otto engine, obtained by Ricardo. In other words, the test gives results approaching the air-cycle efficiency and greater than the air-cycle efficiency with variations in specific heat (Curve B). Obviously the tests do not represent the actual state of affairs, and include several serious mathematical errors."

(YOUNT): "The above paragraphs state the engine has a compression ratio of 4.5 to lay a basis for further argument. The compression ratio is really nearer 5.5 which displaces the critic's argument somewhat. From the critic's own curve he should have been speaking of 46% for the ideal air-cycle Otto engine and, using the correct compression ratio of 5.5, this would be 50%.

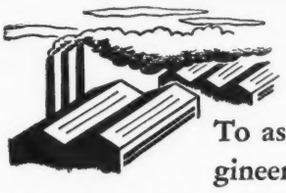
"Then, having corrected his indicated thermal efficiency to 36.4%, his ideal efficiency to 50% and his ratio to 5.5, we get a point which practically drops on the C curve and not above the B curve. Also we figure an 'efficiency ratio' thereby of 72.8% which changes the meaning of his statement in the paragraph above."

Determining Heating Value

(CROSS): "*Let us examine the value given for the gas, namely, 1149 Btu per cu ft. No mention is made as to how the heat value was determined. It should be understood that the Louisiana gas carries a good deal of butane and also casinghead gasoline, in a liquid form. These liquids evaporate when a gas is being tested in a calorimeter (becoming a part of the gas volume) but often are carried along into the engine as a liquid, increasing the actual heating value per cu ft of the gas-air mixture. This might decidedly influence the test value.*"

(NELSON): "The physical setup of the gas system precludes, to my mind, any possibility of liquid in the fuel gas. It seems to me that any heavy distillate would have settled out in the 9- or 10-mile pipeline from the wells to your plant, and would have been caught in your drip pockets, while any lighter distillate, such as butane or propane, would undoubtedly vaporize when the gas-line pressure of 30 or 40 lb was reduced to the low pressure of probably a few ounces, where I understand the test orifice was placed."

(YOUNT): "We see no reason for confusion about 'how the heat value



To assist manufacturers and engineers in finding practical solutions to problems involving the selection, treatment, fabrication and use of alloys containing Nickel, The International Nickel Company, Inc. have compiled essential facts based on years of research and field studies. These facts are condensed into convenient printed form.

Also available for consultation is a staff of experienced engineers—men who have cooperated for years with producers and manufacturers—helping to work out solutions for a wide range of metallurgical problems.

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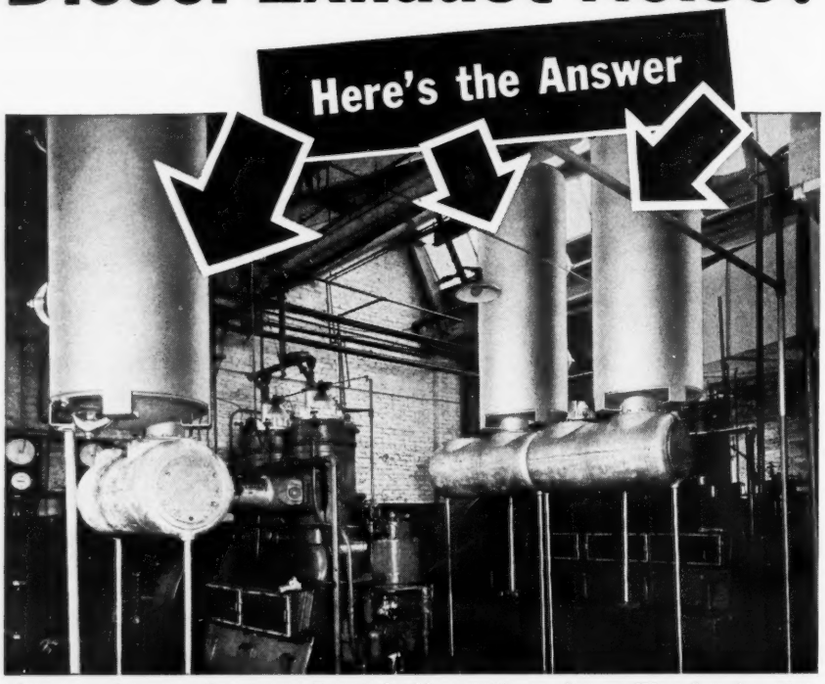
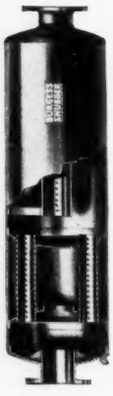
How can I STOP Diesel Exhaust Noise?



Chicago envelope manufacturer uses Burgess Snubbers to silence exhausts of Venn-Severin engines.

No Roar—No High Back Pressure • • • because these Snubbers PREVENT Noise

There's one easy, efficient way to stop Diesel exhaust noise—don't *muffle* it . . . *prevent* it by using a Burgess SDHC Exhaust Snubber. Snubbers do away with exhaust noise by "snubbing the slugs" of exhaust gas. Instead of merely subduing noise, they eliminate the cause of noise—namely, the high pressure, high velocity slugs of exhaust gas that usually strike the atmosphere with a violent impact. Slugs of exhaust gas are snubbed to a smooth, quiet stream before they can cause noise. Fluctuations of pressure in the exhaust piping system are eliminated. Hence, there is no exhaust roar and no objectionable high back pressure. Two snubbing sections give complete silencing and prevent the noise resulting from resonance at pipe frequency.



Sectional view of Burgess Exhaust Snubber.

Burgess Snubbers may be used on any engine, with any length exhaust piping system. For full details of this modern method of exhaust silencing, send the coupon for your copy of Diesel Engine Exhaust Silencing.

Burgess Battery Company, Acoustic Division,
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Please send free booklet, "Diesel Engine Exhaust Silencing":

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BURGESS SNUBBERS

Originators of Snubbing Principle for Quieting Diesel Exhausts—Pat. and Pats. Applied For

was determined.' It is clearly stated in the article that the plant is equipped with a Sargent calorimeter with which gas analyses are made. Both the high and the net value can be determined therefrom and this argument would appear to be a sort of red herring."

(COUGHLIN): "There remains then the question of the heat value of the gas employed. As noted in my earlier letter, gas measurement tests were conducted by thoroughly competent and experienced gas engineers. Three of these engineers were graduate engineers having from 10 to 20 years experience in the natural-gas industry. Gas measurements were made in accordance with Gas Measurement Report No. 2 of American Gas Association which, as you may know, represents the standards of gas measurement formulated by the Association in conjunction with the Bureau of Standards, Bureau of Mines and committees of all engineering societies.

"The heat value of the gas as taken at the time of test was determined by a Sargent calorimeter of the latest design, newly purchased for this plant. Several gas analyses are made weekly by various engineers and operators. Periodically the analyses derived with the calorimeter are checked by combustion analyses in our own gas laboratory in Texas and occasionally by a commercial laboratory. It just happened that we had had no commercial laboratory analysis made at the time of the test, but immediately on receipt of your complaint I sent a sample of gas to the Fort Worth Laboratory and attach hereto a copy of their combustion analysis. At the time the samples were pulled for analysis, calorimeter analyses were made for comparative purposes. The calorimeter analysis consisted of the conventional three series analyses. These showed the following results (August 24): (Hetherwick) First analysis of three series, 1178 gross Btu at 30 in., 60 F. (Tanner) First analysis of three series, 1195 gross Btu at 30 in., 60 F. (Hetherwick) Second of three series, 1184 gross Btu at 30 in., 60 F.

"Please note that these values compared with 1187 gross Btu from the combustion analysis at Fort Worth Laboratory. The gas samples as analyzed are some 38 Btu higher than those at the time of tests. There is, however, nothing significant about this since a variation of that amount would be expected from time to time depending on the amount of hydrocarbons "knocked" out of the gas through a condenser in the field.

"The important result from the com-

Rx . . . a sharp-eyed, quick-witted Hall Service Engineer

TIME: Hall Service engineer's routine call.

PLACE: Atlantic seaboard—Hall-client plant.

TROUBLE SPOTTED: Heavy salt-water contamination in new high-pressure boiler. Condensate from surface condenser of new turbine badly polluted with salt water.

FALSE CLUES: 1. Badly leaking condenser tube; with plant operating, this could not readily be checked.
2. Leak-off drains submerged in salt water; precautions to avoid this had already been taken.

PROBLEM: What *did* cause the trouble?

EYE WORK: Further search revealed a steam seal on condenser-side of turbine, drained by salt-water-actuated eductor three feet below.

TIP-OFF: *The drain line from the steam seal was cold!*

CAUSE AND EFFECT: Due to insufficient steam supply to seal or improper water supply to eductor, turbine vacuum exceeded eductor vacuum, and salt water backed into turbine, then through condenser into boiler.

Rx FOR CORRECTION: Establish proper balance between steam supply and salt-water supply.

RESULTS: Contamination quickly disappeared; plant engineers impressed with speedy, expert service.

MEMORY NOTE: And why not? Immediate *correct* diagnosis prevented *serious* trouble and expenses far in excess of Hall Service fees for a long time to come.

Keeping power plants out of trouble is the Hall Engineer's only job!

THROUGH years of field and laboratory experience, he is attuned, on regular service calls, to spot impending troubles and nip them in the bud.

On emergency calls, when trouble hits hard, you can likewise depend upon him to haul you out with speed, certainty and efficiency. Because his *sole* interest is service, he's always on hand when service is needed and he stays with each job until it is licked.

And backing him up in Pittsburgh is a staff of analytical and research experts whose sole objective, as ever, is SERVICE — through constant refinement in scientific water-conditioning methods.

You can't afford to experiment with unscientific boiler water conditioning. Call in a Hall Service engineer. He'll take that load off your mind and *like* it!

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HALL SYSTEM *of Boiler Water Conditioning*

For peak efficiency, control SLIME and ALGAE in your cooling water system with Santobrite!

Continuous treatment with Santobrite is a simple, inexpensive way to control slime and algae in your cooling water system.

Santobrite (sodium pentachlorophenate) is highly toxic to algae and other slime-forming organisms, and thus keeps cooling water systems free from the adherent, insulating growths that cut condenser efficiency. Yet it is easy to handle, simple to apply, low in cost, and perfectly safe to use in recirculating systems where the water is not used for drinking or bathing.

Write today for Monsanto Technical Bulletin 0-15 which gives complete information on Santobrite—how, when, where, and how much to use for best results. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, St. Louis, U. S. A. District Offices: New York, Chicago, Boston, Detroit, Charlotte, Birmingham, Los Angeles, San Francisco, Montreal.

QUICK FACTS ABOUT SANTOBRITE

1. Essentially unreactive chemically... stable in presence of organic and inorganic substances.
2. In concentrations used for algae control, will not attack metals commonly used in engineering practice.
3. Compatible with other water treatments.
4. Uniformly effective as an algaecide throughout pH range found in cooling practice.
5. Available in one-ounce briquettes, 7 pounds to a cotton bag, 10 bags to a container.
6. Can be applied by simply suspending bag in cooling water.

Detailed directions in Technical Bulletin 0-15

MONSANTO CHEMICALS
SERVING INDUSTRY... WHICH SERVES MANKIND

parative test analyses above is the fact that they are in such close agreement despite the very radical difference in method of determination of heat value. As pointed out in Mr. Nelson's letter, the heat value of the gas is measured at the plant after passing through several miles of pipeline and it would require imagination such as that of your correspondent to develop all the things that might have happened to the heat value.

"I think you will agree that we are actually employing and employed at the time of the test far more than the usual precautions to be certain that our data were correct in terms of standard conventional measurements. I don't know of any gas company which has as much and as complete data with respect to heat value as we have and certainly I know of no other gas consumer who undertakes anything approximating this amount of precaution to determine heat values. We have done this purely with the idea of developing truly representative figures with respect to the efficiency and the functioning of this plant."

ASME Semi-Annual Meeting, June 16-19

The semi-annual meeting of the ASME is scheduled to be held June 16-19, at the Hotel Muehlbach, Kansas City, Mo. Technical program has been announced, which includes several papers of interest to POWER readers. Some of these are: "Colloidal Fuel", by J E Hedrick; "The Firing of Pulverized Coal and other Fuels Together," by A C Foster; "Cooling-Tower Progress," by L T Mart; "Stability Characteristics of Turbine Oils," by L C Welch; "Some Recent Chain-Grate-Stoker Installations," by F X Gilg; and numerous others.

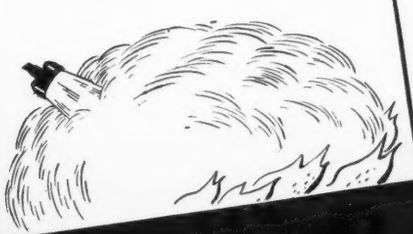
The week before this meeting, June 11-14, the ASME Oil and Gas Power Div will also hold its national meeting in Kansas City. L N Rowley, associate editor of POWER, is secretary of this meeting, which will feature an engineering quiz. Under the guidance of C G A Rosen, Caterpillar Tractor Co, several experts will attempt to answer questions on Diesel and gas engines, submitted by anyone with problems in that field. Prizes will be awarded to those whose questions stump the experts. At other sessions of this meeting there will be papers on engine foundations, automatic protective devices, Diesel insurance, supercharging Diesels, and others.

DEFENSE PLANTS DESERVE THIS

TRIPLE DEFENSE *Against Fire*

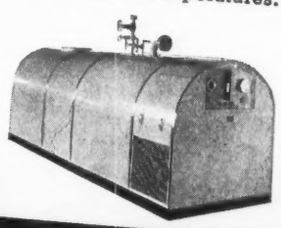
INSTANT SMOTHERING OF FIRE BY CARBON DIOXIDE...

A Cardox Fire Extinguishing System pipes low temperature carbon dioxide to any combination of hazards, releases it automatically in large volume, and freezes out fire instantly. The rapid cooling effect not only slows formation of combustible gases but also lowers temperature below re-kindling point.



... IN VOLUME TO MEET ANY HAZARD ...

An exclusive Cardox development —capacity of 1/4 to 125 tons or more for liquid CO_2 in centralized refrigerated storage for release through a simple piping system to any hazard. Release of CO_2 may be by any combination of manual or automatic controls. Because the temperature of the CO_2 in storage is zero° F, its ability to absorb heat from the fire zone is several times that of the same gas stored at atmospheric temperatures.



... WITHOUT DAMAGE BY THE EXTINGUISHER

CO_2, an inert gas, causes no damage to production equipment and buildings. After-fire clean-up and production outages are held to minimum. Also the tremendous cooling effect limits not only the damage caused by flame but that caused by high temperatures.

● A Cardox Fire Extinguishing System offers practical assurance that fire—accidental or incendiary—shall not needlessly impede production or weaken morale. The essence of a Cardox System is SPEED—unsurpassed speed in preventing fire's damage and spread—accomplished by the release of fire-smothering CO_2 in unprecedented volume and at rates that instantly overwhelm terrific bursts of flame.

Not all big fires start as small ones. For example, where volatile substances are involved the first fire in a room may be large and widespread. Cardox, by creating an atmosphere in which no fire can exist, extinguishes a large fire as readily as a small fire.

Because Cardox stores pure, dry, liquid CO_2 under controlled temperature these systems can be much more positively engineered than is usual in dealing with fire. Such factors as pressure, rate of flow, and expansion being known, Cardox engineers can set up super-human controls for automatic fire extinguishment and show uniform performance. These feature a timed sequence of events including pre-discharge alarm, timed discharge at one or more single or overlapping hazards, and re-set for remaining hazards.

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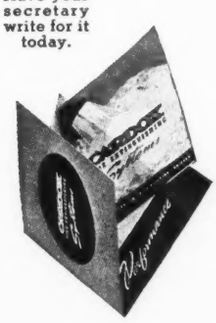

CARDOX

The Non-Damaging Fire Extinguishing System

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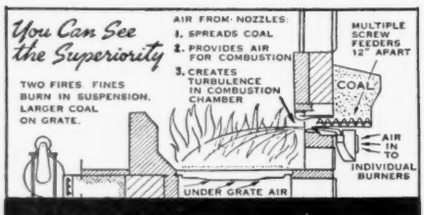
THE high return paid by the first FYR-FEEDER installation in a prominent eastern plant was actually almost unbelievable. In addition to using lower priced fuel, the unit reduced maintenance costs, supervision costs and auxiliary power costs. The total savings were sufficient for the FYR-FEEDER to pay off its cost and buy the second unit shown above — ALL IN LESS THAN A YEAR!

FYR-FEEDER installations that will pay for themselves in one, two, or three years time are known to be possible for hundreds of American plants today. Ability to deliver such a high return is the result of *(1) Low Initial Cost, (2) Easy Installation, (3) Low Operating Cost, (4) Freedom from Expensive Maintenance, (5) Excellent Combustion with Cheapest Coal.* Let us give you an engineering estimate of savings possible in your plant. Write, or use coupon below.


You Can See the Superiority
AIR FROM NOZZLES:
1. SPREADS COAL
2. PROVIDES AIR FOR COMBUSTION
3. CREATES TURBULENCE IN COMBUSTION CHAMBER
MULTIPLE SCREW FEEDERS 12" APART
TWO FIRES: FINES BURN IN SUSPENSION, LARGER COAL ON GRATE.
COAL
AIR IN TO INDIVIDUAL BURNERS
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FOUNDED 1918
Builders of Thousands of Overfeed Stokers

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☐ YES. I want to know what the FYR-FEEDER can do in our plant.

☐ Please mail descriptive literature.

Name_____

Street_____

Town_____

St. Louis Smoke in Hand, Says Tucker

"During the past heating season," reports Commissioner of Smoke Regulation R R Tucker of St. Louis "there were only 17 hours of thick smoke as compared to 115 hours, 50 minutes, during the 1939-40 heating season from September through March. Of the 17 hours recorded, 13 occurred during September and October when many plants and domestic installations were using up old supplies of high-volatile fuel.

"It is interesting to recall," writes Mr Tucker, "that the August 1933 issue of POWER ran the following bit of doggerel by H W Evans, member of the Advisory Board of Engineers of the Smoke Prevention Association of Chicago:

"Year after year we've heard these words spoke,
Educate people and you'll have no dense smoke—
But all the sweet phrases this side o' Hell
Won't catch any cinders, won't wash out the smell.
If you want cleaner air, stop the smoke and dirt shower;
Pass the right kind of law, then enforce it with power."

Dynamic, aggressive, hard-hitting Smoke Commissioner Tucker puts power behind the "right kind of law" to create a cleaner St. Louis.

St. Louis has apparently followed Mr Evans' advice: passed the right kind of law and enforced it with power. That the enforcement as well as the law has been successful is now beyond question.

Meteorologist W J Moxom is quoted as saying "Not only have we had a great deal less smoke, but the little we have had seemed somehow less objectionable than last season's. I'd say it seemed like *cleaner* smoke." Besides a reduction in the number of hours of dense smoke, there has been an increase in the amount of sunlight.

THE SHEPPARD DIESEL

"PACKAGED POWER" UNIT is ready for any service IMMEDIATELY

Adaptable to any power need — primary, emergency or auxiliary—for generator or power take-off—the new, self-contained DIESEL UNIT puts power where you want it on a moment's notice at a fraction of a cent per H.P. hr., using low cost Diesel fuel oil. It's a 4-cycle, 3-cylinder full Diesel—started instantly by battery and developing 25 H.P. (continuous load) at 1200 R.P.M. Close regulation by fly-ball governor assures steady power for flickerless lighting.

Here's CHEAP POWER for MANY PURPOSES

This completely self-contained, compact Diesel power unit is ideal for supplying power for an extra load, for standby service, for emergency power, week-end requirements, auxiliaries of all kinds — in fact for any need where instant and dependable, low cost power is needed in a hurry. Sturdy construction makes the SHEPPARD DIESEL highly suitable also for continuous power service in small plants.

Note these special features

Exclusive design of precombustion chamber for greater power, smoother operation and fuel economy.

A fuel pump and injection system which insures thousands of hours of service without attention.

A complete "Packaged Power Plant" with starting batteries, fuel tank, clutch or generator as desired.

Water pump and fan lubricated for life.

Investigate today—Send for detailed specifications. If you need "power in a hurry"—here it is!

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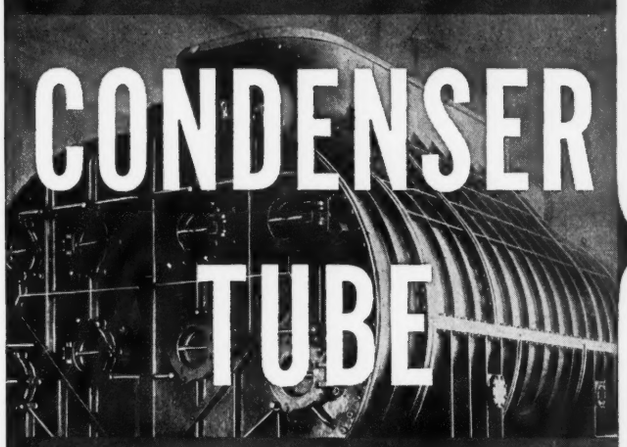
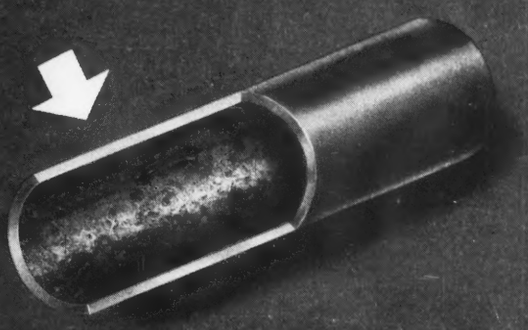
FOR EFFICIENT AND LONG-LIFE CONDENSER TUBE SERVICE



OVERCOME DEZINCIFICATION



WITH BRIDGEPORT ARSENICAL ADMIRALTY

One of the oldest and most popular condenser tube alloys for general all-around use is Admiralty Brass, which contains approximately 70% copper, 1% tin and the balance zinc. But like all brasses, it is subject to dezincification under certain conditions of operation. However, by the controlled introduction of a proper proportion of arsenic, dezincification can be considerably overcome.

For a number of years Bridgeport Brass Company has been supplying Arsenical Admiralty Condenser Tubing as a *standard* alloy, furnishing Admiralty without arsenic only when specifically requested by the user. *This is done in the interest of extending the life of the condenser tubes.* There are often other factors besides dezincification to overcome such as air impingement or localized pitting that may be seriously impairing the efficiency and destroying the life of your condenser tubes. Other alloys are available which are particularly suited to withstand other specific types of corrosive attack. Bridgeport will be glad to help you make sure your installations are...

"ENGINEERED TO YOUR SERVICE REQUIREMENTS"

BRIDGEPORT BRASS

"Bridgeport" BRASS

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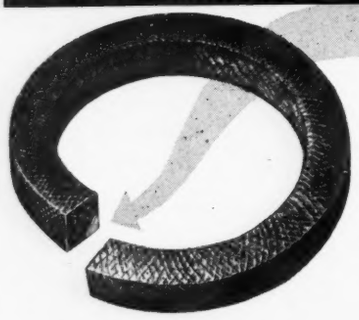
THIS PERMANENT SEALING FEATURE COMES ONLY IN

SEA-RO NEK-SEAL PACKINGS



Once in the stuffing box and set up at proper tension, Sea-Ro Nek-Seal Packing No. 505 will function without further care.

The Nek-Seal element prevents any escape of pressure or liquid through the gland. This packing forms a fine bearing surface when in operation, reducing wear and eliminating scoring of rods.

If high temperatures, pressures or speeds are giving you packing trouble, write us about it. There's no obligation.

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Wherever heavy duty demands extra strength . . . Kewanee Steel riveted boilers are preferred. For the known strength assured by **Steel + Rivets,** supplemented by extra stout stays and braces in the boiler shell, mean many added years of service.

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Avoid accidents! Prevent costly delays! Repair holes, cracks, broken places in concrete floors or resurface an entire area with the durable RUGGEDWEAR RESURFACER. No chopping or chipping required. Merely sweep out the spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Cellulose-Processed to provide a firmer, tougher, smoother, more rugged wearing surface. Used indoors or out. Dries fast. Costs only 10c to 14c per sq. ft.

Valuable 74-page "HAND BOOK OF BUILDING MAINTENANCE" available to those requesting on business letterhead.

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WATER REFINING EQUIPMENT HEADQUARTERS

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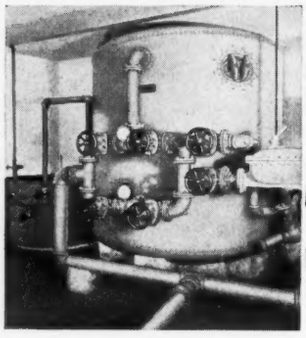

EQUIPMENT

For more than two decades the AMERICAN WATER SOFTENER COMPANY has specialized in designing and manufacturing the mechanical equipment for ZEOLITE (synthetic and natural) Water Softening Systems. Note the easily reached and operated Nest of Control Valves. The direction of flow—when conditions so require—is readily changed. Single Valve Control is available, if desired.

Tell us of your water problems. We can help you.

The AMERICAN WATER SOFTENER COMPANY

WATER REFINING EQUIPMENT HEADQUARTERS

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HOUSEHOLD, ETC.

322 LEHIGH AVE., PHILA., PA.

Dr George T Moore, Director of the Missouri Botanical Garden, stated in a radio address April 6, 1941, "Until this past winter, every year since 1937 has shown a greater amount of sunlight in the country than in the city during that half of the year when sunlight is most necessary. Some years this difference was as great as 150 hours, but this winter, up to the first of March, the record shown only 23 hours more at the Arboretum than in town. One would always expect a slight difference due to local thunderstorms, but this year's 100 hours more sunshine in town than in 1939-40 must mean that something has happened. Something that in all previous seasons of which we have a record did not occur . . . There can be but one answer—Smoke!"

A leading St. Louis nose and throat physician voluntarily makes this statement: "I have been practicing in the ear, nose and throat profession in this city since 1912 and have noticed something unusual this year over every other . . . that is the amount of smoke, dirt and soot that I observe in the inside of peoples noses. The first half or three-fourths of the inside of the nose . . . is known as the vestibule. Heretofore in the winter every St. Louisan that I have treated had a large amount of dirt, smoke and soot in the vestibule of the nose, so that when a treatment was needed it was always necessary to wash out this space with soap and water. During this past year I don't think that I have had to do this more than twice. I also have an office in Belleville, Ill., where the condition of dirt, smoke and soot is still prevalent just as it formerly was in St. Louis."

Progress in St. Louis has been mainly due to having abandoned the time-worn idea of educating the people to hand-fire equipment smokelessly with high-volatile fuel. The program is continuing unabated. A continuity of policy has been assured by the new Administration reappointing the entire personnel of the Smoke Department.

U.S. to Add 3,352,639 Kw

Additional generating capacity totaling 3,352,639 kw will be installed in the United States during 1941, the Federal Power Commission reported May 1 in releasing results of a survey of the electric utility industry. The information obtained indicates that the budgeted expenditures for all electric construction for 1941 will amount to $868,209,000 or approximately $274,329,000 more than the budgeted expen-

NOT 1 BUT 5 . . . THAT'S THE STORY! NOT 1 BUT 5!

The New TAYLOR FULSCOPE CONTROLLER *handles not 1 but 5 Control Jobs!*

YOU can speed up *quality* production by installing the new Taylor Fulscope Controller. It automatically, absolutely, accurately controls processing operations with the utmost precision. It's the faster way to do your best work,"as per orders."

You can economize by installing the new Taylor Fulscope Controller. It's adaptable. It's versatile. Fact is, its unique. The new Taylor Fulscope Controller *grows*, and saves you money by growing.

You may need the Fulscope, at first, to handle simple processing. So you install the basic instrument for that job. Then your needs expand, demanding a controller capable of governing more complicated operations. *Use the same basic Fulscope Controller*—by having other unit assemblies added or substituted in the drilled and tapped Fulscope case. This change-over to a different instrument may be done in the field or on the job. You actually have a new instrument, without having to buy a new one!

Not 1 but 5 available forms of process control—for governing and recording temperature, pressure, liquid level, rate of flow, or combinations—make this Fulscope an essential for *modern* production. It's not a "doctored up" instrument, hasn't merely been "tinkered with" or "improved." This new Fulscope is new. Ask the Taylor man. Or write Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada.

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Not 1 but 5 . . . ***All these Forms of Control available in New Taylor Fulscope Controller***

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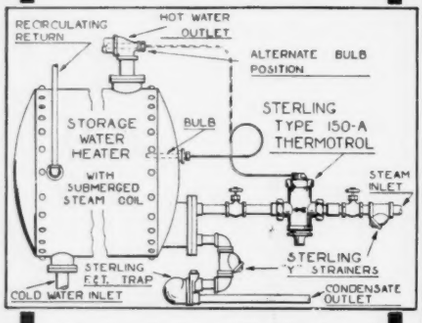

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ditures for 1940 reported at the beginning of that year.

The report presents detailed data for scheduled additions to generating plants by privately and publicly owned utilities, subdivided by states and type of prime mover. In the more detailed analysis of the results of the survey, it was reported that privately owned electric utilities plan to add 14,450 kw of hydroelectric generating equipment and 2,078,721 kw of steam and internal-combustion generating equipment. Similarly, according to the report, publicly owned utilities plan to add 987,047 kw of hydroelectric generating equipment and 272,421 kw of steam and internal-combustion generating equipment.

CORRECTION

Near the middle of the second paragraph of "Check Phase Rotation," by C A Le Quesne, in answer to Question No. 2, page 107, May POWER, a sentence reads: "Note the direction of the motor rotation, then open the disconnects in the incoming line and oil switch and again note the direction of the motor rotation." This should read: "Note the direction of motor rotation and then open the disconnects to stop the motor. Then close the disconnects in the incoming line, close the oil switch and again note the direction of the motor rotation."

MEETINGS

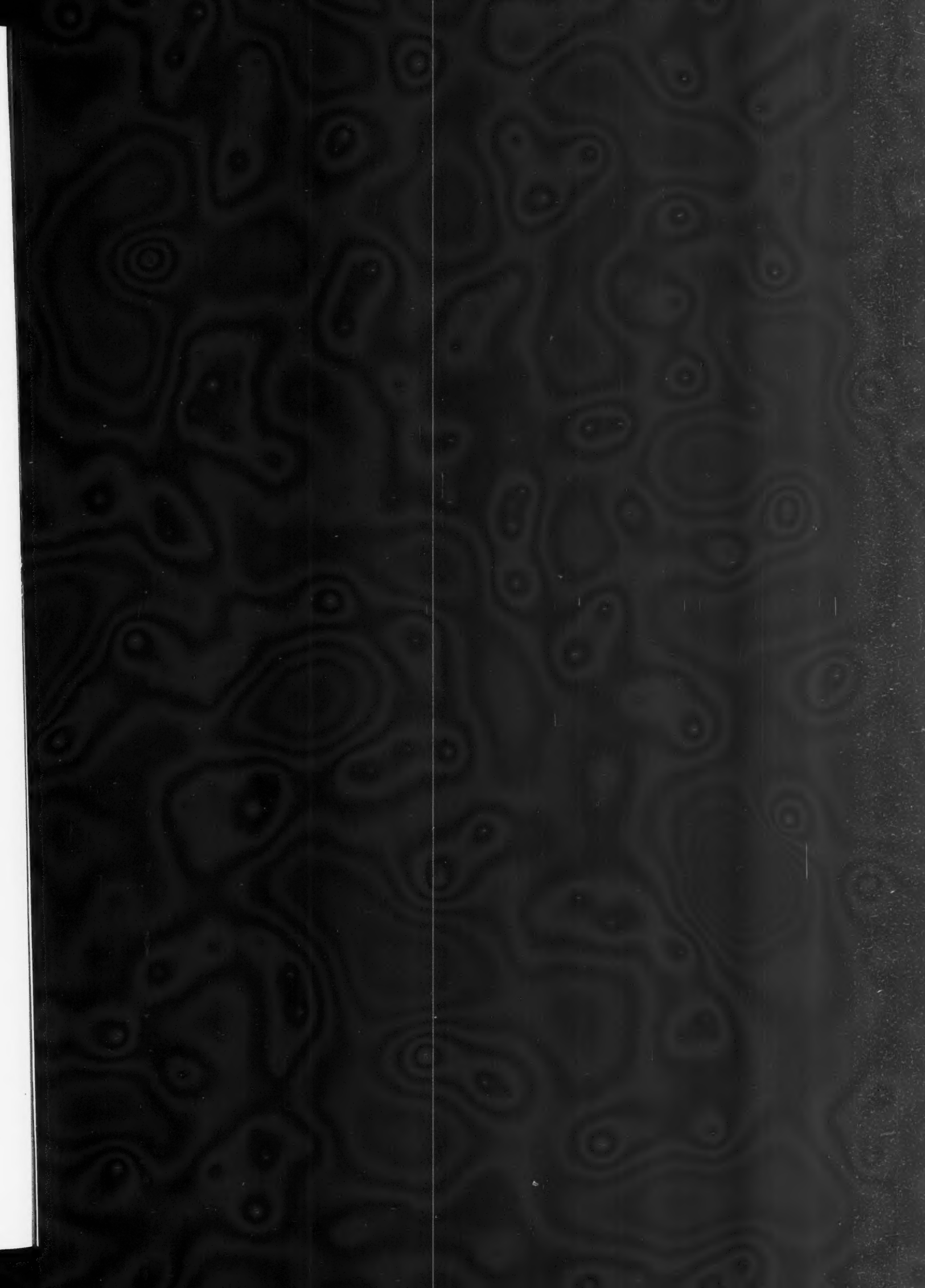
American Association for the Advancement of Science—*108th Meeting, June 23–28, Durham, N. H.*

American Institute of Electrical Engineers—*Summer Convention, June 16–20, 1941, Toronto, Ontario, Canada. H H Henline, national secretary, 33 W 39 St, New York, N. Y.*

American Society of Mechanical Engineers—*Semi-Annual meeting, June 16–20, 1941. Hotel Muehlbach, Kansas City, Mo. Oil and Gas Power Div, Meeting June 11–14, Kansas City, Mo. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Society of Heating and Ventilating Engineers—*Semi-Annual meeting and Pacific Coast Heating and Air Conditioning Show, June 16–20, 1941. Palace Hotel, San Francisco, Calif.*

National District Heating Association—*Annual meeting, June 10 to 13, 1941. William Penn Hotel, Pittsburgh, Pa. John F Collings, Jr, secretary-treasurer, 1231 Grant Bldg, Pittsburgh, Pa.*

Smoke Prevention Association—*35th Annual Convention, June 3–6, Hotel Ansley, Atlanta, Ga., Assn headquarters, 139 N Clark St, Chicago, Ill.*

Society for the Promotion of Engineering Education—*49th Annual meeting, University of Michigan, Ann Arbor, Mich. June 23–27, 1941.*